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THE EFFECTS OF STATUS, COST, AND AUTHORITARIANISM ON A SUBORDINATE'S CHALLENGING/MONITORING BEHAVIOR IN A COCKPIT SIMULATION

A Thesis

Presented to

the Graduate School of

Clemson University

In Partial Fulfillment

of the Requirements for the Degree

Master of Science

Applied Psychology

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by

Sean K. Carey

May 1997

May 2, 1997

To the Graduate School:

This thesis entitled "The Effects of Status, Cost, and Authoritarianism on a Subordinate's Challenging/Monitoring Behavior in a Cockpit Simulation" and written by Sean K. Carey is presented to the Graduate School of Clemson University. I recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science with a major in Applied Psychology.

Fred A. Switzer, III
Thesis Advisor

We have reviewed this thesis
and recommend its acceptance:

Accepted for the Graduate School:

Jamie M. Boggs

ABSTRACT

This research examined the challenging/monitoring communications behavior of 60 college undergraduates fulfilling the role of copilot in a cockpit simulation. The status of the pilot and cost of not challenging/monitoring the pilot's performance were manipulated. The number of task relevant communications, timing of these communications, and type of communications made by the subjects and directed at the pilot were measured. A measure of authoritarianism was also accomplished by the subjects. The results showed a significant status by cost interaction for the number and timing of communications variables. Subjects paired with low status pilots were more aggressive in their communications behavior under conditions of high cost than low cost of not challenging/monitoring. Subjects paired with high status pilots were more aggressive under conditions of low cost than high cost of not challenging/monitoring. Also, subjects paired with low status pilots used more direct styles of communication than those paired with high status pilots. These findings imply that when a copilot is paired with a high status pilot who makes a serious mistake, he/she is least likely to be aggressive in challenging such an error. In other words, copilots are most passive when their input is needed the most. Such findings have training, performance and safety implications.

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DEDICATION

This thesis is dedicated to my wife, Corinne, and children, Sam, Erin, and Anna. Nothing written here can express the degree of gratitude which is owed them. Their daily sacrifice and unconditional support throughout the years have allowed me the freedom to accomplish what otherwise would be impossible.

TABLE OF CONTENTS

Table of Contents (Continued)

LIST OF TABLES

List of Tables (continued)

LIST OF FIGURES

CHAPTER I

INTRODUCTION

Flightcrew behavior has been cited as causal in or contributing to the majority of fatal aircraft accidents (NTSB, 1994). In order to examine flight crew behavior and environmental factors in fatal accidents, the National Transportation Safety Board (NTSB) (1994) conducted a safety study of major aircraft accidents of U.S. air carriers between 1978 and 1990. Of the 37 accidents examined in the study, 302 specific errors were identified. Procedural errors, tactical decision errors, and failure to monitor or challenge another crewmember's error were the most common types of errors identified.

Of the 37 accidents examined in this study, 31 involved monitoring/challenging failures. Of these 31 accidents, 90 percent of the errors that went unchallenged by other crew members were cited as causal or contributing to the cause of the accident. Such results highlight the importance of good cockpit communications and the negative consequences of poor communications. As a result of this study, the NTSB made recommendations to the Federal Aviation Administration. The need to train copilots on how to challenge/monitor and pilots on how to receive such challenges was evident throughout the recommendations section of the report.

Such results provide testimony to the importance of monitoring the performance of the other crew members and adequately challenging them when errors in performance are evident. Despite this level of importance, it is not difficult to conceive of instances when the challenging of another person's performance is more difficult than others. The first pilot or flight engineer observing the unsafe conduct of their captain is one situation in which hesitation to challenge may occur, due to the inherent difference in status of the individuals involved. Because of the critical nature of flying operations, such hesitation on the part of a subordinate may have dire consequences.

An example of this type of hesitancy or reluctance to intervene is provided by Foushee (1982, p. 1063). He notes the following copilot account of an incident as reported through the NASA/FAA Aviation Safety Reporting System:

> I was the copilot on a flight from JFK to BOS. The captain was flying. Departure turned us over to Center and we were given FL210, which was our flight plan altitude. I noted that we had reached FL210 and were continuing through it, but was reluctant to say anything. As we climbed through 21,300 ft (6428 m), I mentioned it to the captain, but not forcefully enough, and he did not hear me. I mentioned it again and pointed to the altimeter. We were at 21,600 ft (6583.7 m) when the climb was stopped, and we descended back to 21,000 ft (6400.8 m)....

Later, the copilot attributed the deviation to his reluctance to correct the captain, and not due to the captain being unapproachable. This incident did not involve a loss of life or damage to the aircraft, but is indicative of the communications behavior of subordinates in the cockpit. The results of two other incidences illustrate the importance of the challenging /monitoring function in the cockpit and the consequences of inadequate action on the part of subordinates.

In 1978, a DC-8 ran out of fuel and crashed several miles from the Portland airport. Prior to the crash, the crew was busy diagnosing a problem with a gear indicator light (a burned out light bulb) and formulating a plan. The cockpit voice recorder indicated that the flight engineer had repeatedly advised the pilot concerning their low fuel state, but that such advisories were ignored. The NTSB included the following comments in their accident report (as cited by Foushee and Helmreich, 1988):

> Admittedly, the stature of a captain and his management style may exert subtle pressure on his crew to conform to his way of thinking. It may hinder interaction and adequate monitoring and force another crewmember to yield his right to express an opinion.

In 1982, a B-737 crashed into the 14th Street Bridge in Washington, D.C., immediately following takeoff. The indicators for engine thrust were not providing true thrust readings due to partially blocked pitot static tubes. As a result, the pilot thought adequate takeoff thrust was established, when in fact less than essential power was set. The cockpit voice recorder indicated that the copilot made some subtle communications to the pilot regarding the problem, but these were not considered by the pilot. In the accident report, the NTSB implied that a primary cause of the accident was the copilot's lack of assertiveness and a general hesitancy on the part of subordinates in challenging superiors (Foushee and Helmreich, 1988).

The general purpose of this research was to examine some of the factors which may influence a subordinate's challenging/monitoring communications behavior in the cockpit. This research attempted to answer several questions. First, what is the effect of relative social status and cost of not challenging superiors on the challenging/monitoring behavior of subordinates in a cockpit environment? Also, to what degree does relative social status and cost of not challenging/monitoring superiors interact with one another?

An additional research question involves a personality variable and arises from past research involving status effects. Past research implies that authoritarianism may interact with status effects to influence a subordinate's challenging/monitoring behavior. The last research questions extend the others by incorporating authoritarianism: What is the effect of authoritarianism, status and cost of not challenging superiors on the challenging/monitoring behavior of subordinates in a cockpit environment? Is there an interaction of these variables which impacts the subordinate's challenging/monitoring behavior? For the purposes of this research, "challenging/monitoring behavior" is defined as the verbal communications of the subordinate and directed at the pilot regarding specific flight operations.

Foushee and Helmreich (1988) outline a model of factors which affect group performance. This model provides a framework from which to interpret the research conducted. In their model, these researchers identify input variables, process variables, and outcome variables. Input variables include individual factors (physical state, skills, personality, etc.), group factors (structure, size, compatibility, etc.) and environmental variables (stresses, task design, organizational structure, etc.). Process variables include factors such as communication and coordination, as well as feedback mechanisms from the outcome variables. The outcome variables include performance factors such as safety and efficiency, along with changes in satisfaction and attitudes of those involved. Within this framework, this research examined the effects of three input variables (status within the group, authoritarianism of the subject, and cost of not challenging/monitoring) on the process variable of communication.

Status Characteristics Theory

Status characteristics theory (Humphreys and Berger, 1981) and affiliated research provide for predictions regarding challenging/monitoring behavior of subordinates in the cockpit. The theory attempts to explain the effects of status on social interactions from an expectation states and status generalization approach.

Central to status characteristics theory is the general concept of a status organizing processes. "A status organizing process is a process by which differences in cognitions and evaluations of individuals or social types of them become the basis of differences in the stable and observable features of social interaction (Humphreys and Berger, 1981, p. 954)." These differences in interactions are a manifestation of the relative expectations of performance that individuals have of one-another.

Performance expectations are theoretical constructs that are unobserved, but believed to exist according to status characteristics theory. In other words, people behave as if they form expectations of one's relative abilities compared to others when accomplishing a task. When the expectations are higher for one subject over another, that subject is more likely to be given opportunities to contribute, take action based on those opportunities, be rated positively on their performance, be influential in decision making and less swayed by the opinions of others (Ridgeway, 1985).

These performance expectations are a result of external status characteristics, according to the theory. Differences in status characteristics result in differences in performance expectations that participants hold for themselves, relative to others. This results in corresponding differences in power and prestige, and affiliated behaviors (Ridgeway, Berger, and Smith, 1985).

Two types of characteristics are noted by these theorists - diffuse and specific status characteristics. Diffuse characteristics have been formally defined by three conditions (Humphreys and Berger, 1981, p. 955): "(1) it involves two or more states which are differentially valued; (2) associated with each state are distinct sets of specific expectation states, each themselves evaluated; and (3) associated with each state is a similarly evaluated general expectation state." The formal definition of a specific status characteristic is (Humphreys et al., 1981, p. 955): "(1) it involves two or more states that are differentially evaluated and (2) associated with each state is a distinct expectation state."

Differences between these status characteristic types can be noted from these definitions. Diffuse characteristics are more global in nature, and are affiliated with general performance expectations that are assumed to have application to a host of situations. Specific characteristics have more narrowly defined expectations associated with them and are applicable in a defined set of circumstances. Typical examples of diffuse characteristics may be race or sex, while examples of specific characteristics may be reading or math ability (Ridgeway et al., 1985).

Empirical evidence supports the idea that individuals combine, not selectively eliminate, characteristics in the formulation of performance expectancies, when faced with multiple characteristics (Webster and Driskell, 1978). Empirical evidence also supports the proposition that status differences affect performance expectations in the group, regardless of the applicability of the status characteristic to the task at hand (Berger, Cohen, and Zelditch, 1972). These characteristics are considered in the formulation of expectancies unless proven to be irrelevant.

An important component of the status characteristics theory is status cues. Status cues are information (verbal and nonverbal) used to infer status in social situations. They range from level of vocabulary used in verbal communication to number and type of personal possessions one may have. Berger, Webster, Ridgeway, and Rosenholtz (1986) identify two dimensions along which status cues may vary. One dimension makes the distinction between indicative cues and expressive cues, while the other makes the distinction between task and categorical cues.

Cues which explicitly identify someone as possessing a certain status are considered indicative. On the other hand, cues which implicitly identify someone as possessing a degree of status are expressive. Diplomas and certificates, along with statements such as, 'I have a Clemson Ph. D.' or 'I have done this before' are examples of indicative cues. Expressive cues include things such as eye contact, speech speed and loudness, and posture, along with skin color, ethnic dialect, and gender and race specific speech patterns (Berger et al., 1986).

Independent to this dimension is the task-categorical distinction of status cues. Task cues are those which provide information concerning current performance. They allow inferences to be made regarding the level of performance exhibited by someone and their general abilities in contributing to the task at hand. Task cues can be either explicit or indicative, and include such things as eye contact and posture, or a statement such as 'I know how this works'. Categorical cues indicate a status category individuals belong to. They provide information as to the nature of the individual and include such things as skin color and ethnic dialect, or a statement such as 'I am a behavioral scientist'.

Berger et al. (1986) provide two empirical generalizations concerning research conducted on expressive cues (task and categorical) from various fields, including linguistics, psychology, sociology, and anthropology. The first generalization is specific to homogeneous status situations, as when two individuals are of the same sex or age group (p. 7):

> In homogenous situations, if individuals differ in terms of task cues, this leads to correlated differentiation in power and prestige behaviors and/or assessments of task capacity.

The second generalization made by Berger et al. (1986) involves heterogeneous situations in which individuals differ in status along such things as race and sex (p. 8):

> In heterogeneous situations, if individuals are differentiated in terms of status characteristics, then their differentiation on task cues will coincide with their status differentiation in the given situation.

In other words, task cue behavior differences between participants in this situation will be in line with their status differences.

Berger and colleagues provide a theoretical explanation for these empirical generalizations. In the first generalization, expectancy states are affected in a systematic and differential manner, depending on the task cues exhibited. High expectations result from high task cue behavior, while low expectations result from low task cue behavior. For example, influence in a group has been shown to result from persistent eye contact.

This can be explained as the eye contact cue differentially affecting expectation states which in turn produce different levels of power and prestige.

The second generalization is also explained in terms of status characteristics theory. In this case, status characteristics lead to differences in expectation states, which in turn produce different levels of task cue behavior. This type of causal chain is supported by independent research on nonverbal cues and status conducted by Ridgeway et al. (1985).

Berger et al. (1986) also cite research supporting the idea that differentiation in categorical cues also results in differential expectancy states and displays of task cue behavior. They also entertain the possibility in which high (low) task cues correspond with low (high) categorical cues. As stated previously, expectation states result from the combination of all information. However, according to these theorists, not all cues are evenly weighted in this combination process. When task cues and irrelevant, diffuse categorical cues are combined, task cues should dominate. Dependent power and prestige behaviors should reflect this.

Predictions Based on Status Characteristics Theory

Status characteristics theory provides for relevant predictions with regards to the challenging/monitoring behavior of subordinates in the cockpit. According to the theory and empirical generalizations above, subjects should not display the same degree of task cue and control communications behavior for low and high status targets. A subject's expectancy state will be lower than that of a high status target, resulting in the lack of display of task cue and control behavior. However, a subject's expectancy state will be higher than that of a low status target, resulting in the display of task cue and control behavior. In an equal status situation, exhibition of task cue behavior will result in differential expectancy states. In this case, control behavior may or may not be exhibited, depending on this factor. However, in general, degree of task cue and control behavior should be more than with high status targets.

Research accomplished by Palmer, Lack, and Lynch (1995) support these predictions for a cockpit environment. These researchers examined the types of and number of commands given by 22 captains and 22 first officers in transferring control of the aircraft between one another. The researchers used status characteristics theory to form their hypotheses concerning the number and type of communications which would be involved in the transfer of aircraft control. As status characteristics theory would predict, the captains controlled the transfer of aircraft control by making more transfer initiations, even when the captains were not flying at the time of transfer. Also, the captains used more direct commands to initiate transfers than first officers. The researchers also noted that first officers never used direct commands to initiate transfer when not in control of the aircraft.

Authoritarianism and Status

This review of authoritarianism includes a brief examination of two definitions of authoritarianism. The purpose of this is not to draw lines between them and arrive at a position in support of one over the other. Rather, they are reviewed in order to give context to the reader on what is meant by authoritarianism. The research results and definitions provided here support the hypothesized relationships entertained in this research.

The first major publication on authoritarianism came from a group of researchers based at the University of California, Berkeley. The Authoritarian Personality (Adorno, Frenkel-Brunswik, Levinson and Sanford, 1950) was the culmination of their work and provided the basis for a vast amount of research examining the dynamics of this personality trait. The original intention of these researchers was to examine the underlying mechanisms of anti-Semitic and ethnocentric behavior. The end result of their work was the creation of the F (fascism) scale.

The F scale consisted of items associated with nine inter-correlated variables which were used to define the fascist or authoritarian personality. These nine variables were believed to combine into a "single syndrome", and were defined by the researchers as (Adorno, et al., 1950, p. 228):

1. Conventionalism. Rigid adherence to conventional, middle-class values.

2. Authoritarian submission. Submissive, uncritical attitude toward idealized moral authorities of the ingroup.

3. Authoritarian aggression. Tendency to be on the lookout for, and to condemn, reject, and punish people who violate conventional values.

4. Anti-intraception. Opposition to the subjective, the imaginative, the tender-minded.

5. Superstition and stereotypy. The belief in mystical determinants of the individual's fate; the disposition to think in rigid categories.

6. Power and toughness. Preoccupation with the dominance-submission, strong-weak, leader-follower dimension; identification with power figures; overemphasis upon the conventionalized attributes of the ego; exaggerated assertion of strength and toughness.

7. Destructiveness and cynicism. Generalized hostility, vilification of the human.

8. Projectivity. The disposition to believe that wild and dangerous things go on in the world; the projection outwards of unconscious emotional impulses.

9. Sex. Exaggerated concern with sexual goings-on.

Adorno and his colleagues attributed much of the behavior of authoritarians to their upbringing. Their research revealed that prejudiced subjects tended to come from households in which strict discipline, conditional affection, the acting out of clear dominant/submissive roles, and a special concern for status were prevalent. The child eventually develops aggression in response to parental authority. This aggression, which cannot be directed toward the dominant parents, is displaced onto others. The researchers cite this as the most probable source of aggression directed toward members of minorities. The researchers express this best in saying, "...the prejudiced subject's ambivalence toward his parents, with a repression and externalization of the negative side of this ambivalence, may be a factor in determining his strongly polarized attitudes, such as his uncritical acceptance of the ingroup and violent rejection of the outgroup (p. 482)."

The ingroup is defined by these researchers as the group which the high authoritarian identifies with. The ingroup is characterized by the high authoritarian as being more sophisticated, morally superior, and having high status and power. The high authoritarian believes in a strong sense of commitment to the ingroup, and displays submission and blind loyalty to their causes. The outgroup, on the other hand, is characterized as weak and powerless, yet seen as threatening to the high authoritarian.

Members of outgroups are viewed as subordinate in status and power, but who are attempting to better there status in society (Adorno et al., 1950).

This ingroup/outgroup dichotomy appears to dominate the social conceptions of the high authoritarian. The researchers summarized their position regarding this issue by saying (Adorno et al., 1950, p. 150):

> Ethnocentrism is based on a pervasive and rigid ingroup-outgroup distinction; it involves stereotyped negative imagery and hostile attitudes regarding outgroups, stereotyped positive imagery and submissive attitudes regarding ingroups, and a hierarchical, authoritarian view of group interaction in which ingroups are rightly dominant, outgroups subordinate.

The researchers characterize the low authoritarian as someone who does not stereotype individuals, but rather judges each on the basis of their own unique qualities. He/she is not overly sensitive to status and power, and is able to display more open disagreement with and defiance of authoritative figures (Adorno et al., 1950).

While used widely throughout the years in various research settings, this scale and associated theory have not gone without criticism. Christie (1991) points out two identified failings of the F scale dealing with response set bias- acquiescence and social desirability. All the items on the F scale were written in pro-trait form. Because of this, no difference between the respondent who agreed with the content of the question and the respondent who generally agrees with everything could be detected. Also, because many of the items were so negative and inflammatory, respondents may disagree with them in order to shed a favorable impression on their goodness. Several attempts have been made to revise the scale and theory throughout the years. The most recent and a well recognized revision was one accomplished by Altemeyer (1981).

Altemeyer took exception with much of the research which has been conducted since publication of The Authoritarian Personality. He characterized the theories proposed to explain authoritarianism as “loosely concocted and downright superficial” (Altemeyer, 1981, p. 112). Also, he notes that scales have been hastily developed and implemented before establishing their scientific basis. Through his examination of the literature and development of his scale, he noted that only three of the nine original factors supposedly tapped by the F scale remained consistent in discriminating between authoritarians and nonauthoritarians. These three factors were re-defined by Altemeyer and are the centerpiece of his definition of right-wing authoritarianism. He defines them as “three attitudinal clusters” (p. 148) which covary to define the authoritarian (Altemeyer, 1981, p. 148):

1. Authoritarian submission - a high degree of submission to the authorities who are perceived to be established and legitimate in the society in which one lives.

2. Authoritarian aggression - general aggressiveness, directed against various persons, which is perceived to be sanctioned by established authorities.

3. Conventionalism - a high degree of adherence to the social conventions which are perceived to be endorsed by society and its established authorities.

Altemeyer clarifies his interpretation of the measurement of authoritarianism. He recognizes the difference between attitudes and behaviors and notes that just because an individual is high in authoritarianism does not mean he/she will act or behave in that manner in all instances. There are situational factors and individual differences which influence the behavior of an authoritarian and may inhibit the display of otherwise authoritarian type behavior.

The Right Wing Authoritarian (RWA) scale was developed by Altemeyer in an attempt to clarify the definition of the construct, and handle previous scales' problems with counterbalancing of items and reliability. To handle the problem of reversals, he set forth stringent criteria that items had to meet in order to be retained. Following a series of studies, Altemeyer arrived at a 24 item counterbalanced scale which was measured using a seven point Likert scale (7 representing high authoritarianism) (Christie, 1991).

Administration of the original scale to 956 University of Manitoba students resulted in an alpha reliability of .88 in 1973. With a revised 30 item scale, Altemeyer reports alpha reliability coefficients ranging from .85 to .89. Test-retest reliability among student samples have ranged from .85 to .95, depending on the interval used (Altemeyer, 1988). Zwillenberg (1983) reported an overall reliability of .90 in a study involving students from several colleges.

The validity of the RWA scale was supported when Altemeyer compared different measures of authoritarianism and their correlation with different criterion measures which had been used in past research. The measures of authoritarianism included the F scale (Adorno et al, 1950), the Dogmatism Scale (Rokeach, 1960), the Conservatism Scale (Wilson and Patterson, 1968), the Balanced F Scale (Lee and Warr, 1969), the Authoritarianism-Rebellion Scale (Kohn, 1972), and the RWA scale (Altemeyer, 1981).

The results indicated a superiority of the RWA scale over the others. The RWA scale showed the highest internal consistency of the measures, and was the best predictor of authoritarian tendencies on five of the six criterion used. Altemeyer further supported the validity of the RWA scale by employing a Milgram (1969) type paradigm with college students. Of the measures mentioned, the RWA scale had the highest correlation, .44, with the display of aggression through continued shocking of peers (Altemeyer, 1981).

Relevant Authoritarianism Research

Several predictions can be made based upon the review of authoritarianism. First, high authoritarians are more likely to display general aggression towards others than low authoritarians. Second, high authoritarians are more aggressive towards those of low status than those of high status, and finally, low authoritarians are essentially unaffected by status and power, and therefore display generally non-aggressive behavior (Zwillenberg, 1983).

In general, research appears to support these predictions. A main effect for authoritarianism in terms of aggression has been found in several studies. Altemeyer (1981) demonstrated this effect through his Milgram paradigm referenced previously. Epstein (1965) Larsen, Lancaster, Lesh, Redding, White, and Larsen (1976), Epstein (1966), Elms and Milgram (1965), using a similar paradigm, also revealed this tendency of high authoritarians to display more aggressiveness than low authoritarians. Altemeyer (1988), following a series of experiments examining high and low authoritarians' punitiveness in law cases, supports the findings of these previous researchers.

An authoritarian by status interaction has also been demonstrated in research. However, the pattern of results has not been as consistent as the main effect for authoritarianism. Thibaut and Riecken (1955) observed high authoritarians displaying more aggressive communications behavior toward low than high status individuals.

Epstein (1965) also noted this tendency of high authoritarians using the Milgram paradigm - high authoritarians displayed more aggressiveness toward low than high status targets. Contrary to this trend is research conducted by Lipetz and Ossario (1967). They found no increase of aggressiveness toward equal status targets compared to high status targets. However, they did comment that an interaction may have evolved if low status subjects had been used instead of equal status subjects.

The research conducted by these researchers also sheds light on the behavior of low authoritarians. Epstein (1965) found that low authoritarians displayed more aggression toward high than low status targets, and Lipetz and Ossario (1967) found the same trend but with equal status targets. Zwillenberg (1983) in examining punitiveness to crimes and authoritarianism, found the same aggressive tendency of low authoritarians toward high status figures. However, Thibaut and Riecken (1955) found no relationship between low authoritarians and status in terms of displays of aggression. Also, Altemeyer (1988) concluded from his research on the subject that "Highs and lows are apparently not equally hostile toward their respective foes. Authoritarians appear substantially more aggressive, toward a vast, bewildering array of potential victims (p. 120)".

From the research reviewed, it appears that at least some empirical evidence on this point (low authoritarian behavior) may be in conflict with the model of the authoritarian proposed by Adorno and his colleagues. The research reported here will provide additional evidence as to the dynamics involved and perhaps the situational factors upon which this apparent effect occurs.

Cockpit Communications Behavior and Performance

This research examined the effect of different input variables on the communications behavior of subordinates in the cockpit. It does not examine or measure flight crew performance. However, from the research reviewed below and the NTSB (1994) study referenced previously, their appears to be strong evidence to suggest that the quality and quantity of crew communications significantly impacts crew performance.

Ruffell Smith (1979) conducted a simulation study in which B-747 flight crews accomplished a flight profile in which numerous aircraft malfunctions and problems were interjected. Numerous flight crew performance variables were examined. Foushee and Manos (1981) analyzed the cockpit voice recordings yielded from this study and found important results. Flight crew performance was inversely related to the number of crew communications - the more the crew communicated, the better the performance. When more information was transferred concerning flight status, fewer errors were made. They found a significant, negative correlation between crew observations and system operations errors, and between commands and flying errors.

Another flight crew simulation study yielded similar results. Foushee, Lauber, Baetge, and Acomb (1986) studied fatigue and circadian rhythm disruption on the performance of transport crews. Their results showed that crews that had flown together communicated more and performed better than crews who had not flown together. Captains and first officers on familiar crews issued more commands, made more suggestions, and made more statements of intent than crews made up of individuals unfamiliar with one another. Also, first officers who were more familiar with their captains expressed more disagreement.

This pattern of results seems to suggest that decreased familiarity between crewmembers results in ineffective crew communications, decreased performance, and an increase in the number of errors. Findings from the NTSB (1994) study appear to support this. Most of the fatal accidents examined and where data was available (11 of 15 accidents, or 73%) occurred on the first day the captain and first officer had flown together. Because of this apparent effect, familiarity was held constant and as low as possible, in order to simulate the worst case scenario for crewmembers in terms of expected communications and performance effectiveness.

Cost of Not Challenging/Monitoring

The potential negative consequences and costs associated with errors depends on the type of error committed and context of the situation. To a pilot, being 100 feet low while cruising at 35,000 feet is not the same in terms of risk as being 100 feet low at the minimum descent altitude during the final approach to landing at a busy airport. Pilots are trained to understand the risks involved in different phases of flight and situations. So, it is reasonable to believe that their motivation to challenge/monitor is higher when the potential costs of errors are high, than low. In acknowledgment of this possible effect, cost of not challenging/monitoring the pilots performance was manipulated in this research.

With the introduction of this variable into the research, it allowed for an examination of a possible interaction with status. It was believed copilots would be more aggressive in their challenging/monitoring behavior when costs were high than low, and that this would be true across status conditions. However, this effect would be more apparent in the high status condition. It was reasoned that copilots would already be displaying a high degree of aggressiveness in their challenging/monitoring behavior with low status pilots, leaving little opportunity for an increase in aggressiveness. However, in the case where copilots are paired with high status pilots, this ceiling effect would not be apparent. Since they are relatively unaggressive with their high status pilots without the cost factor, these copilots have more opportunity to increase their degree of aggressiveness as costs increase.

Variables and Hypotheses

The subjects in this research acted as copilots in the accomplishment of a personal computer based flight simulation game. The role of pilot was fulfilled by the experimenter. The subject and experimenter were expected to fly a flight profile according to instructions given by a simulated air traffic control (ATC).

Three independent variables were represented in this research: status of the pilot, cost of not challenging/monitoring the pilot's performance, and authoritarianism of the subject. Three dependent variables were measured in this research: number of task relevant communications made by the subject to the pilot, timing of the first input relative to an ATC assigned flight parameter, and the type of task relevant communications provided by the subject and directed at the pilot. All three of these variables were thought of in terms of degree of aggressiveness displayed by the subject. The subject will provide many inputs, provide them early, and be more direct in the type of communications used when he/she is aggressive. When he/she is not aggressive, subjects will not communicate much with the pilot, be late in communicating information, and be less direct in the type of communication used.

The theories and research reviewed thus far provide support for the following hypotheses:

1. Copilots will be more aggressive in their challenging/monitoring communications behavior when the status of the pilot is low than when it is high.

2. Copilots will be more aggressive in his/her challenging/monitoring communications behavior when the cost of not challenging/monitoring is high than when it is low.

3. High authoritarian copilots will be more aggressive in their challenging/monitoring communications behavior than low authoritarian copilots.

4. An interaction is hypothesized between authoritarianism and status. High authoritarian copilots will be more aggressive in their challenging/monitoring communications behavior with low status than high status pilots. Low authoritarians will not be more aggressive with low than high status pilots.

5. An interaction is hypothesized between cost of not challenging/monitoring and pilot status. Copilots will be more aggressive in their challenging/monitoring communications behavior for the high cost of not challenging condition in both status conditions. However, this effect will be more dramatic when the pilot is of high status than low status.

No hypotheses are made concerning a cost of not challenging/monitoring by authoritarianism interaction or a three-way interaction due to the lack of experimental and/or research support. However, these interactions will be examined as part of the statistical analysis.

CHAPTER II

METHOD

A laboratory setting was used for the subjects to assume the role of a copilot in a pilot-copilot team whose task was to fly the personal computer based game of Microsoft Flight Simulator 5.1 (Artwick, 1995) through an experimentally created flight profile. The experimenter assumed the role of the pilot during the experimental session, while a confederate played the role of air traffic control (ATC). All three positions were connected through an interphone system involving headphones and microphones. The subjects' challenging/monitoring communications behavior was measured.

Use of personal computer based flight simulation games has been used effectively by other researchers (Volpe, Cannon-Bowers, Salas, and Spector, 1996) to examine team process and outcome variables. Microsoft Flight Simulator 5.1 (Artwick, 1995) was designed for use by one individual, but as discussed below, is segmented to provide a meaningful task for the experimental team to accomplish. Its use is believed to create a sufficiently realistic cockpit setting for examination of the variables of interest.

Measures

Independent Variables

Status and cost of not challenging/monitoring are manipulated as described below. A questionnaire was administered following the flight simulation to check the effectiveness of these manipulations. The 1996 Right Wing Authoritarian scale (Altemeyer, personal communication, June 20, 1996) was also administered to the subjects following the flight simulation.

Dependent Variables

ATC instructions were received by the flight team (experimenter and subject) via an interphone system. The experimenter (pilot) seemingly flew the simulator via a joystick according to instructions set forth by ATC. The timing of first input, number of inputs, and type of communication variables were determined from a videotape of the simulation phase. This videotape captured the instrument panel as seen by the subject, and audio of the transmissions made by ATC, the pilot, and the subject.

Following the running of all subjects, the experimenter viewed the videotape of each experimental team accomplishing the flight profile. The profile consisted of 18 interchanges between ATC and the flight team. Table A-I outlines the flight profile. The first three interchanges with ATC were not scored, in order to allow the subject to become comfortable with the task. Of the remaining 15 interchanges with ATC, 5 pertained to a change in altitude and 5 with a change in heading. These 10 interchanges yielded all of the experimental data. The remaining five interchanges were not scored - they were requests by ATC for airspeed and transponder settings, and were employed in order to make the subjects task more multi-dimensional and keep them active in their duties as copilot.

Of the five changes in altitude and heading parameters, three involved mistakes in which the ATC directed headings/altitudes were purposely not complied with (indicated in Table A-I as 'Not Comply'). In each of these cases, the aircraft was flown approximately 20 degrees past the assigned heading or 500 feet past the assigned altitude, and then returned to the ATC assigned heading/altitude. The interjection of purposeful errors into the task was accomplished in order to measure the subject's challenging/monitoring behavior when faced with performance errors of others. Such a practice was cautiously recommended by the NTSB (1994) for crewmember training sessions in order to ensure crews were confronted with such situations and to address challenging/monitoring behaviors.

Timing of the first input was determined by the feet prior to/after the assigned altitude and the degrees prior to/after the assigned heading at which the copilot (subject) provided task relevant input to the pilot (experimenter). All times were annotated in hundredths of seconds. When the communication was provided prior to the assigned altitude/heading, a stop watch was started when the subject began his/her communication and was terminated upon reaching the assigned heading/altitude (within five degrees/100 feet and the parameter stopped increasing/decreasing). In this case, the time was assigned a negative value. When the communication was provided after the assigned altitude/heading had been past (as in the case of purposeful errors), the stop watch was started upon passing the assigned altitude/heading and terminated when the subject began his/her communication. In this case, the time was assigned a positive value.

If the subject provided no task relevant communication to the pilot, the time was annotated as zero for those cases when the ATC instructions were complied with. For those cases when the instructions were purposely not complied with and the subject provided no communications, timing was annotated as the time from passing the assigned heading/altitude to when the aircraft was reestablished at the assigned heading/altitude (within five degrees/100 feet and the parameter stopped increasing/decreasing).

This procedure yielded a total of 10 times for each subject. The mean of these times was determined, providing for the timing of first input variable which was subject to statistical analysis.

The number of inputs variable was determined by the total number of task relevant, copilot (subject) communications directed at the pilot for the entire flight profile. This number was arrived at by summing the number of inputs for each of the 10 changes in the altitude and heading parameters. Appendix B provides an explanation of what is meant by 'task relevant communications'. The pilot, in each of the cases, responded to the copilots communication by responding 'roger'.

Each of the communications provided by the subject and directed at the pilot was coded into five different categories, as outlined in Appendix B. Only the number of directive, information/observation, and inquiry type communications were subject to statistical analysis and used in determining the number of inputs and timing of first input variables. Non-task and mistake type communications were determined, but not used. This coding scheme is based on previous research conducted by Fjelde (1992) and is similar to coding schemes used by Volpe et al. (1996) and Foushee et al. (1981).

Participants

Subjects were acquired from a university student population by advertising the research in various introductory psychology courses with extra credit offered for participation. Data from 60 of the 79 college undergraduate participants were subject to statistical analyses. Random assignment was used to place fifteen of these subjects into each of the four experimental conditions created from the status and cost of not challenging/ monitoring variables. The first 10 subjects were lost due to alterations in the training protocol and shortening of the flight profile session following their participation. Of the remaining nine subjects that were dropped, one was lost due to his age not conforming to experimental limits, another was a foreign subject who was embarrassed about her poor english communication skills, one displayed erratic and unstable behavior, and six were lost due to computer malfunctions.

LaRue and Cohen (1987) found a difference between male and female perceptions of warnings in survey research they conducted. Also, women have been shown to conform more than men when involved in face-to-face social interactions (Cooper, 1979). Because of these previous findings, male and female subjects were distributed evenly across conditions. Eight female and seven male subjects were randomly assigned to each of the four experimental conditions.

The age difference between the subject and experimenter was seen as an important extraneous variable. Subjects older than the experimenter could have been less inclined to be influenced by the status variable than subjects younger than the experimenter. The same could have been true for subjects who were closer in age to the experimenter than those who were considerably younger. For these reasons, the same limited age group (18-26 years) was targeted for this experiment. The decrement in external validity is recognized, but appears worthwhile when considering the possible decline in internal validity if no controls are exercised. Relying on this method of control appears more effective than merely relying on random assignment of subjects to groups.

Since the relative age of the experimenter to the subject was an issue, it is appropriate to mention the characteristics of the experimenter (pilot). A 34 year old male fulfilled the pilot role in this experiment. In the high status condition, he dressed in his standard Air Force uniform, and was introduced to the subject as a flight instructor pilot in the U.S. Air Force with over 2500 hours of flight experience. In the low status condition, the experimenter dressed in typical street clothes and was introduced to the subject as a fellow student. No deception was used in this procedure due to the experimenter's actual status as a student and Air Force pilot. Also, both diffuse and specific status characteristics are represented, enhancing the differential in the status condition. It was believed to more accurately portray a real world situation in which the high status individual possesses a greater degree of expertise in the domain of interest.

The introduction of experimenter bias into the experiment was of concern. However, any individual who fulfilled the role of the pilot in this situation would have knowledge of the status condition, based on the introduction made and clothing worn. The behavior of the experimenter was scripted and kept constant across status conditions. Also, the experimenter was blind to the cost condition of the subject.

Materials

Microsoft Flight Simulator 5.1 (Artwick, 1995) was integral to the task the subject performed in this research. It is designed for use by one person, but was adapted for experimental purposes to accommodate accomplishment by two persons. The breakdown of functions by crew position (pilot or copilot) is displayed in Table C-I.

An IBM compatible personal computer (Pentium processor, 75 MHz) with a joystick, and 15 inch monitor was used to accomplish the simulation. The monitor was placed on a table between the pilot and copilot positions. Conventional office type chairs were used to seat the individuals at their stations.

An interphone system was used for communications between ATC, pilot, and copilot. Each of the three positions had headphones and a microphone. These were connected so that any transmission made by any of the positions was heard by all. Interphone systems are integral to communication in cockpits and provided a means of measuring timing and number of copilot communications.

Background noise was provided by the flight simulation program and external computer speakers, in order to reinforce the use of the interphone system instead of face to face/cross-cockpit communication. Also, background noise is inherent to cockpits, and therefore provided a realistic environment in which to accomplish the task.

An 8mm video camera was used in recording the instrument panel of the aircraft as presented on the monitor and audio from the interphone system. The signal from the camera was fed to a VHS video cassette recorder, which was used to record the session.

A television and video cassette player were used for training of the subjects. The training video explained the responsibilities and duties of the copilot position and introduced them to the simulation. It also provided an example by portraying two individuals accomplishing a flight profile correctly, and instructed the subject on how to operate the interphone system and communicate with the pilot.

Procedure

Appointments were made for the subjects to arrive at the laboratory. Upon arrival, the confederate had the subjects sign an informed consent form. Along with typical information, the informed consent statement informed the subjects that they were eligible for a $50 cash prize through a drawing, contingent upon some experimental conditions. The confederate then provided the subjects with the laboratory handout in Appendix C, and read it to them. As noted in Appendix C, not all subjects received the same instruction sheet. The subjects assigned to the high cost of not challenging/monitoring condition were informed that their chance of winning the $50 cash prize is not automatic. They were informed that there is a danger of colliding mid-air with other air traffic if off assigned headings and altitudes. Should they collide with other aircraft, they sacrifice all possibility of receiving the cash prize for their participation. The subjects in the low cost of not challenging/monitoring condition received none of this information.

In using this procedure, some deception was introduced into the experiment in order to manipulate the cost of not challenging/monitoring variable. In actuality and regardless of the experimental condition, there was no chance of the subjects colliding with mid-air traffic, so all subjects had an equal chance of winning the $50 cash prize.

The subject was then trained on his/her responsibilities as the copilot. An outline of the training phase is provided in Appendix D. This training included the viewing of a videotape which explained the controls and displays, the responsibilities of the copilot, and provided an example of two individuals accomplishing the tasks. Appendix E contains an outline of the contents of the video. The training also included a practice session in which the subject practiced the tasks which he/she was primarily responsible for in accomplishing the flight profile. Most of the copilot's duties involved communicating with ATC, and relaying of instructions to the pilot. Also, the subjects were encouraged to provide task relevant information to the pilot at any time. They were told to monitor the pilot's performance and communicate to him should he make a mistake. They were told that accomplishing the profile is a team, not individual, effort.

Upon completion of the training phase, the subject began the simulation phase of the experiment (Appendix A). The confederate retrieved the experimenter from another room and introduced him to the subject. The introduction was made in the manner outlined above, depending on the status condition the subject was assigned to. The confederate then guided the two through an interphone practice session. Once the subject felt comfortable with interphone operations, the confederate started the camera and recorder. The confederate also explained that he was leaving the room to act as ATC, in order to cut down on the background noise introduced into the interphone system. Since he would be viewing the team through a one-way mirror on one wall of the room, he assured the team that nothing unusual was taking place on the other side of the mirror - he would only be viewing them as they executed the profile.

The profile dictated by the confederate (ATC) is outlined in Appendix A. It started with the team ready for takeoff at the end of the runway and terminated following the accomplishment of all 18 interchanges between ATC and the flight team.

The experimenter (pilot) did not actually control and manipulate the aircraft using the joystick. The recorder function of the simulation program was used to record the execution of the profile in the absence of the subjects (prior to subject participation in the experiment). The experimenter merely acted out control inputs using the joystick during the simulation phase. This was done to control for the variability in experimenter performance which would have otherwise existed. In this way, each subject was exposed to the exact same profile, with identical turning and climb/descent rates. The timing of instructions provided by the confederate (ATC) were consistent with the timing of maneuvers executed by the computer. In other words, just prior to the computer changing heading or altitude, the confederate made the appropriate instruction to the flight team. This timing was choreographed prior to subject participation in the experiment.

Appendix F outlines the activities accomplished in the post-simulation phase. Once the profile was completed, the confederate asked the pilot to pause the program. He then dismissed the pilot and had the subject complete a questionnaire (Appendix G) and the RWA (Appendix H). With these accomplished, the subject was debriefed as to the purpose and importance of the experiment, the deception used and the justification for the use of deception. Care was taken to ensure that any stress created by the experimental situation and use of deception was dissipated prior to their departure from the laboratory setting. No subjects reported any problems with the use of deception.

Following the debriefing, the subjects were informed of the approximate date and location of the posting of the research results. They were also informed that once data collection was complete, information (date, time and location) regarding the drawing for the cash prize would be posted.

CHAPTER III

RESULTS

The results of this experiment are broken into two parts for readability and understanding. First, the primary results which reflect the effects of status, cost of not challenging/monitoring, and authoritarianism on the subjects' challenging/monitoring communications behavior will be presented. Next, the secondary results pertaining to the subjects' responses to the post-simulation questionnaire items will be presented.

Primary Analysis

The two status and cost conditions were dummy coded as 0 (low) and 1 (high) for the statistical analyses. The 1996, 34 item Right Wing Authoritarian scale yielded a continuous score based on the scoring protocol provided by Altemeyer (personal communication, June 20, 1996). The possible range of this score was from 30 (low authoritarian) to 270 (high authoritarian). The timing of first input, number of inputs, and type of communications data were coded as specified in the methods section. The protocol for the coding of communications is provided in Appendix G.

Table I-I (Appendix I) displays the descriptive statistics for the data. It includes the data for the subject population, and data pertaining to each of the possible cell conditions created from the status and cost of not challenging/monitoring conditions. It is important to note that for the timing of first input variable, smaller values indicate that the subjects provided inputs earlier than larger values. In other words, the smaller the value for the timing of first input variable, the more aggressive the communications behavior.

Table I displays the Pearson correlations among variables. A regression analysis found the relationships between status and number of inputs ($r = -.43$, $F(1,59) = 13.136$, $p = .001$), and status and timing of first input ($r = -.432$, $F(1,59) = 13.333$, $p = .001$) to be significant. The relationship between the number of inputs and timing of first input was also found to be significant ($r = -.947$, $F(1,59) = 501.856$, $p < .001$).

Table I. Pearson correlations for status, cost, RWA, timing of first input, and number of input variables.

	Status	Cost	RWA	Timing of First Input	Number of Inputs
Status	1.000				
Cost	0.000	1.000			
RWA	-0.045	-0.100	1.000		
Timing of First Input	0.432*	0.058	-0.119	1.000	
Number of Inputs	-0.430*	-0.077	0.041	-.947**	1.000

(*$p = .001$, **$p < .001$)

Initially, a manual stepwise multiple regression procedure was used to examine the effects of the independent variables (status, cost of not challenging/monitoring, and authoritarianism) on the number of inputs dependent variable. A regression procedure was chosen due to the continuous nature of the authoritarianism scale (RWA). Through this analysis, it was found that authoritarianism and all associated interactions were not significant in the prediction of the number of inputs variable at the $p < .05$ level. Following this determination, an ANOVA analysis was used to examine the effects of the remaining dichotomous variables (status and cost of not challenging/monitoring) on the number of inputs variable. The results of this analysis are provided in Table II. Status was found to be significant ($F(1,59) = 14.375, p < .001$), along with the status by cost interaction ($F(1,59) = 7.016, p = .01$). However, cost of not challenging/monitoring was not found to be significant ($F(1,59) = 0.456, p = .502$). These variables accounted for 28.1% of the variance in the number of inputs variable ($R^2 = .281$).

Figure 1 and Table III can be used to interpret the significant effects due to status and the status by cost interaction on the number of inputs variable. For the status main effect, subjects paired with low status pilots provided a significantly greater number of inputs (mean = 6.23) than those paired with high status pilots (mean = 3.80). Post hoc pairwise comparisons using Tukeys Honestly Significant Difference (HSD) tests were accomplished to explain the status by cost interaction. It was found that subjects in the low status - low cost condition did not provide a significantly greater number of inputs than those in the low status - high cost condition ($p = .162$). However, subjects in the high status - low cost condition provided a significantly greater number of inputs than those in the high status - high cost condition ($p = .03$). Also, subjects in the low status - low cost condition did not provide a significantly greater number of inputs than those in the high status - low cost condition ($p = .453$). Finally, subjects in the low status - high cost condition provided a significantly greater number of inputs than those in the high status - high cost condition ($p < .001$).

Analysis of the timing of first input data was accomplished in the same manner as that done for the number of inputs data. The result of the manual stepwise multiple regression was the same; authoritarianism and affiliated interactions with status and cost of not challenging/monitoring were not found to be significant at the $p < .05$ level. As with the number of inputs variable, an ANOVA was then accomplished to examine the effects of status and cost of not challenging/monitoring on the timing of first input variable. The results of this analysis are provided in Table IV. Status was found to be significant ($F(1,59) = 15.094$, $p < .001$), along with the status by cost interaction ($F(1,59) = 9.392$, $p = .003$). However, cost of not challenging/monitoring was not found to be significant ($F(1,59) = 0.270$, $p = .605$). These variables accounted for 30.7% of the variance in the timing of first input variable ($R^2 = .307$).

Figure 2 and Table V can be used to interpret the significant effects due to status and the status by cost interaction on the timing of first input variable. In interpreting Figure 2, one must understand that the earlier inputs are provided by the subject, the lower the timing of first input score. For the status main effect, subjects paired with low status pilots (mean = 3.239) started providing inputs significantly earlier than subjects paired with high status pilots (mean = 7.655). As with the number of inputs variable, post hoc pairwise comparisons using Tukeys Honestly Significant Difference tests were accomplished to explain the status by cost interaction for the timing of first input variable. It was found that subjects in the low status - low cost condition started providing inputs significantly later than subjects in the low status - high cost condition ($p = .038$). Also, subjects in the high status - high cost condition started providing inputs significantly later than those in the high status - low cost condition ($p = .036$). However, subjects in the high status - low cost condition did not provide inputs significantly later than those in the low status - low cost condition ($p = .600$). Finally, subjects in the high status - high cost condition provided inputs significantly later than those in the low status - high cost condition ($p < .001$).

The number of subjects who provided no task relevant communications to the pilot and the distribution of these subjects by condition were also of interest. As depicted in Table VI, 9 of the 60 subjects (15%) provided no task relevant communications to the pilot. Most of these subjects (66%) were from the high status - high cost of not challenging/monitoring condition.

The number of subjects who acted in a proactive fashion by providing inputs prior to the ATC assigned heading/altitude and the distribution of these subjects by condition were examined as well. As depicted in Table VII, only 11 of the 60 subjects (18.3%) provided at least one communication prior to the ATC assigned headings/altitudes. When considering the total data set, there were 600 possible times when subjects could provide task relevant communications to the pilot and from which data was taken (10 opportunities for communication for each of the 60 subjects). Only 37 of these 600 opportunities for communication (6.17%) involved a subject communicating task relevant communication to the pilot prior to the ATC assigned heading/altitude.

A chi-square analysis was used to test for a possible relationship between types of communication used, and the status and cost conditions. The observed frequencies for the three types of communications entertained (directive, information/observation, and inquiry) are displayed in Table VIII. No significant relationship was found between cost and types of communications used (χ^2 (2) = 5.21, $p > .05$). However, a significant relationship between status and types of communication used was (χ^2 (2) = 10.116, $p <$ .05). Directive type communications accounted for 10.7% of the communications in the low status condition, but only 5.3% of the communications in the high status condition. On the other hand, inquiry type communications accounted for 4.4% of the communications in the high status condition, but were never used in the low status condition. Information/observation type communications were essentially equal across conditions in terms of percentage of total communications within each group (90.4% for high status and 89.3% for low status).

Another analysis was conducted to examine further the relationship between the status and cost variables, and the types of communication used. For this analysis, the types of communication data were transformed to represent values along an aggressiveness continuum. Inquiry communications were coded as 1's, information/observation communications were coded as 2's, and directive communications were coded as 3's. In other words, directive communications were assumed to be the most aggressive and inquiry communications the least aggressive. If no communications were provided, the score was annotated as zero. The number of communications provided by each subject within each of these categories was multiplied by these values, to yield a score within each category. The scores for each category were then summed to determine an overall score of aggressiveness for each subject with regards to the types of communication used. The descriptive statistics for each cell created from the status and cost of not challenging/monitoring conditions are provided in Figure 3. Table IX provides a graphical representation of the data.

Twenty of the sixty subjects were randomly chosen and re-coded by the primary investigator to attain a test-retest reliability coefficient. Ten days elapsed between coding periods. Also, another rater, following the guidance of Appendix G, rated the same twenty subjects to yield an inter-rater reliability coefficient. Table X displays the results of this analysis. Reliability coefficients ranged from .841 to 1.000. No coefficients were calculated for the number of mistakes, inquiries, or non-task type communications due to the lack of data for these categories of communication.

The internal consistency reliability of the RWA was determined by calculating a coefficient alpha. Coefficient alpha for all items of this scale was .918.

Table II. ANOVA results for the number of inputs dependent variable.

N = 60 | Multiple R = 0.530 | Squared Multiple R = 0.281

Source	Sum of Squares	DF	Mean-Square	F-Ratio	P
		Analysis of Variance			
Status	88.817	1	88.817	14.375	0.000
Cost	2.817	1	2.817	0.456	0.502
Status*Cost	43.350	1	43.350	7.016	0.010
Error	346.000	56	6.179		

Table III. Descriptive statistics for the number of inputs variable.

		COST	
		Low mean (s.d.)	High mean (s.d.)
STATUS	Low	5.60 (2.75)	6.87 (2.03)
	High	4.87 (2.53)	2.73 (2.58)

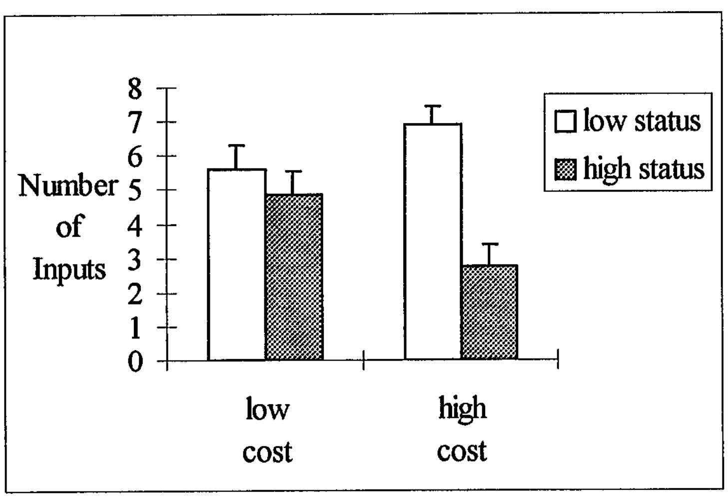

Figure 1. Status by cost interaction for the number of inputs variable.

Table IV. ANOVA results for the timing of first input variable.

N = 60 | Multiple R = 0.554 | Squared Multiple R = 0.307

Analysis of Variance

Source	Sum of Squares	DF	Mean-Square	F-Ratio	P
Status	292.507	1	292.507	15.094	0.000
Cost	5.238	1	5.238	0.270	0.605
Status*Cost	182.004	1	182.004	9.392	0.003
Error	1085.217	56	19.379		

Table V. Descriptive statistics for the timing of first input variable.

		COST	
		Low mean (s.d.)	High mean (s.d.)
STATUS	High	5.62 (4.97)	9.69 (5.14)
	Low	4.69 (4.63)	1.79 (2.22)

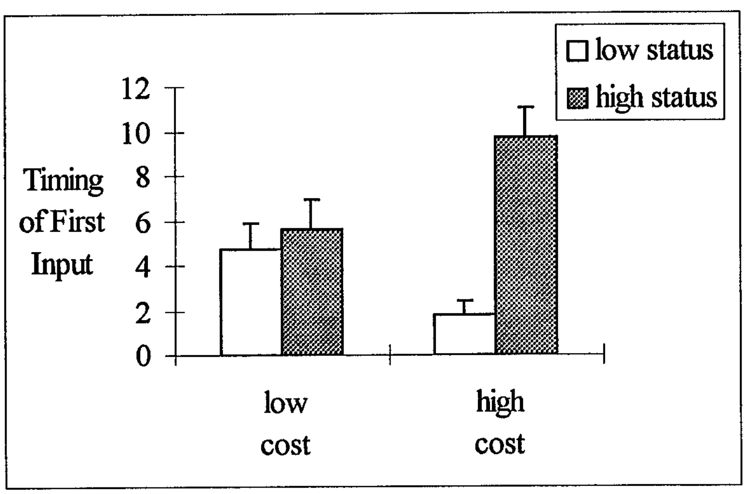

Figure 2. Status by cost interaction for the timing of first input variable.

Table VI. Number of subjects who provided no task relevant communications.

Condition	Number of Subjects (percentage of subject population)
Low Status - High Cost	0 (0 %)
Low Status - Low Cost	1 (1.67%)
High Status - Low Cost	2 (3.33%)
High Status - High Cost	6 (10.00%)
Total	9 (15.00%)

Table VII. Number of subjects who provided communications prior to the ATC assigned headings/altitudes.

Condition	Number of Subjects (percentage of subject population)
Low Status - High Cost	4 (6.67%)
Low Status - Low Cost	3 (5.00%)
High Status - Low Cost	3 (5.00%)
High Status - High Cost	1 (1.67%)
Total	11 (18.33%)

Table VIII. Observed frequencies of directive, information/observation, and inquiry type communications for the status and cost conditions.

	Type of Communication			
Condition	Directive	Information/ Observation	Inquiry	*Totals*
High Status	6	103	5	114
Low Status	20	167	0	187
Totals	26	270	5	301

	Type of Communication			
Condition	Directive	Information/ Observation	Inquiry	*Totals*
High Cost	18	123	3	144
Low Cost	8	147	2	157
Totals	26	270	5	301

Table IX. Descriptive statistics for the aggressiveness - types of communication variable.

		COST	
		Low mean (s.d.)	High mean (s.d.)
STATUS	Low	11.73 (5.95)	14.53 (4.63)
	High	9.60 (5.08)	5.67 (5.79)

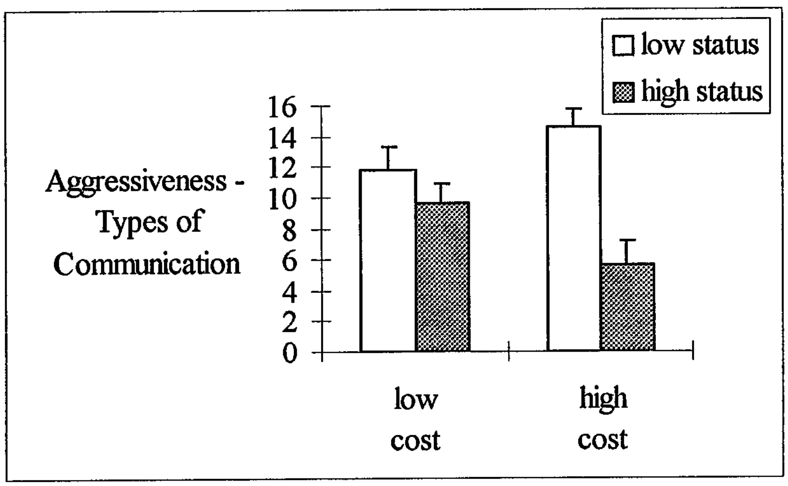

Figure 3. Cell means of the aggressiveness-types of communication variable.

Table X. Reliability coefficients for number of inputs, timing of first input, number of directive communications, and number of information/observation communications.

	Type of Reliability Coefficient	
Variable	Test-retest	Inter-rater
Number of Inputs	1.000	.992
Timing of First Input	1.000	.999
Number of Directive Communications	1.000	.841
Number of Information/ Observation	1.000	.973

Secondary Analysis

There were 13 items on the post-simulation questionnaire (Appendix F). Two of the items (questions one and two) were designed to measure the effectiveness of the status manipulation. A different two (questions five and six) were designed to measure whether the subjects understood the instructions pertaining to the cost manipulation. Three items (questions three, four, and seven) were present to check the effectiveness of the cost manipulation. Three additional items (questions eight, nine, and ten) measured the subjects' degree of familiarity with flying and flight simulation computer games. The subjects indicated their sex, age, and academic major in the last three items. Table J-I presents descriptive statistics (number, range, mean and standard deviation) associated with these questions.

The first two questions were designed to check the status manipulation. For the first question, subjects indicated the general social status of the pilot on a seven point likert-type scale. An independent samples t-test with the data grouped by the status condition was accomplished. No significant difference was found between the low and high status conditions ($F(1,57) = 2.681, p = .107$).

For the second question, the subjects rank ordered seven work classifications from highest to lowest in terms of social status. In order to make it simple for the subjects, a '1' was given to the highest social status classification and a '7' given to the lowest. For statistical analysis, these rankings were inversed. 'Military officer' and 'College student' were two of the classifications to be ranked. Questions '2A' and '2B' of Table J-I represent the descriptive statistics for the ranks provided for military officer and college student respectively. A Wilcoxon signed rank test was applied to the ranks from these two groups to test for a possible difference between them. Table XI displays the results from this test. This test indicated that military officers were ranked significantly greater in social status than college students ($p < .001$).

Questions five and six were designed to answer the following question: From the training provided, did the subjects understand the consequences of being off ATC assigned headings/altitudes? For these questions, the subjects indicated how not complying with ATC instructions and getting into a mid-air collision would affect their chance of winning the cash prize on a seven point likert-type scale (from 'Not affect my chances at all' to 'Severely affect my chances of winning'). The pearson correlation between these questions was found to be significant ($r = .796$, $F(1,59) = 100.112$, $p < .001$). Because of this, the scores from these two questions were summed for further analysis. A regression analysis revealed a significant relationship between the cost conditions and the sum of responses from these questions ($r = .748$, $F(1,59) = 73.884$, $p < .001$). High cost subjects' responses (mean of 12.7) were significantly greater than low cost subjects' responses (mean of 5.4).

Questions three, four, and seven were designed to check the effectiveness of the cost manipulation. Significant correlations between the responses to these questions were expected, but not achieved. Question three was significantly correlated with question four ($r = .443$, $F(1,59) = 14.166$, $p < .001$), and question seven was significantly correlated with question four ($r = .445$, $F(1,59) = 14.323$, $p < .001$); however, a significant relationship between questions three and seven was not found ($r = .206$, $F(1,59) = 2.559$, $p = .115$). For this reason, the questions were treated separately for further analysis.

Question three asked the subjects how important it was for them to follow ATC instructions. They responded on a seven point likert-type scale from 'Not important' to 'Extremely important'. A regression analysis found the relationship between cost conditions and the responses to this question not to be significant ($r = .102$, $F(1,59) = .608$, $p = .439$).

Question four asked the subjects how important it was for them to avoid a mid-air collision in accomplishing the flight profile. They responded on a seven point likert-type scale from 'Not important' to 'Extremely important'. A regression analysis found the relationship between cost conditions and the responses to this question not to be significant ($r = .172$, $F(1,59) = .172$, $p = .188$).

Question seven asked the subjects if the chance of getting into a mid-air collision motivated them to communicate more with the pilot. They responded on a seven point likert-type scale from 'Not motivated at all' to 'Extremely motivated'. Another regression analysis was used to determine the relationship between the cost conditions and the responses to this question. No significant relationship was found ($r = .185$, $F(1,59) = 2.062$, $p = .156$). However, a significant relationship was revealed between their responses to this question and the cost conditions in subjects paired with low status pilots ($r = .373$, $F(1,29) = 4.523$, $p = .042$). Within the low status condition, the high cost subjects' mean response (5.933) was significantly greater than the low cost subjects' mean response (4.600).

Table XII presents the relationships between the subjects' responses to questions 8 through 12, and the number of inputs and timing of first input variables. Simple regression analyses were used to test these relationships. As can be seen from this table, no significant relationships between the subjects' responses and the number of inputs and timing of first input variables were determined.

Questions eight and nine were designed to measure the degree of familiarity the subjects had with flying. Question eight asked the subjects to rate their familiarity with flying, excluding those times when they were just a passenger. They responded on a seven point likert-type scale from 'Not familiar at all' to 'Extremely familiar'. Regression analyses was used to determine the relationship between the number of inputs and the timing of first input variable, and their responses to this question. No significant relationship was found.

Question nine asked subjects if they had a pilot's license, student's license, or any experience at the controls of an aircraft, along with how many hours of flying time in any of these capacities they had logged. Only 2 of the 60 subjects indicated experience at the controls of an aircraft. Regression analyses revealed no significant relationship between the number of inputs and the timing of first input variable, and their responses to this question.

Question 10 asked the subjects to rate their degree of familiarity with flight simulation computer games. They responded on a seven point likert-type scale from 'Not familiar at all' to 'Extremely familiar'. Regression analyses revealed no significant relationship between the number of inputs or the timing of first input variable, and the responses to this question.

Question 11 asked the subjects to indicate their sex, while question 12 asked for their age in years. Regression analyses revealed no significant relationship between the number of inputs or timing of first input variable, and their responses.

Table XI. Wilcoxon signed ranks test results for question two of the post simulation questionnaire.

Counts of Differences (row variable greater than column)

	Military Officer	College Student
Military Officer	0	40
College Student	13	0

Z score

	Military Officer	College Student
Military Officer	0	
College Student	-3.65*	0

* $p < .01$

Table XII. Correlations and significance levels associated with the relationships between questionnaire items 8 through 12, and the number of inputs and timing of first input dependent variables.

Question	Correlation with Number of Inputs	Correlation with Timing of First Input
8	.086 (F(1,59)=0.437, p = .511)	.025 ((F(1,59)=0.036, p = .850)
9	.064 ((F(1,59)=0.242, p = .624)	.099 ((F(1,59)=0.572, p = .452)
10	.241 ((F(1,59)=3.580, p = .063)	.177 ((F(1,59)=1.885, p = .175)
11	.219 ((F(1,59)=2.913, p = .093)	.133 ((F(1,59)=1.040, p = .312)
12	.103 ((F(1,59)=0.617, p = .435)	.147 ((F(1,59)=1.288, p = .261)

CHAPTER IV

DISCUSSION

Challenging/monitoring failures in the cockpit were identified as a serious problem by the NTSB (1994). As a result, the NTSB made specific recommendations to the FAA in the interest of minimizing the problem. Most of the recommendations emphasized the need to train crews in challenging/monitoring the performance of others in the cockpit.

In any case involving safety, there is an urgency to take action in the interest of minimizing the effects of a problem. However, the exact nature of the problem may remain unknown or in the least, ambiguous. This ambiguity in problem definition may lead to an inappropriate or ineffective response. Training programs may be developed with good intentions, but without a clear understanding of the problem. The research reported here serves to define more clearly the challenging/monitoring problem in the cockpit. It is hoped that such knowledge will be used in the development of effective training programs and organizational procedures designed to combat the problem.

This research does not provide an exhaustive definition of the challenging/monitoring problem. However, it does narrow our definition and understanding of the psychological and social factors involved. It was designed to answer this question: What is the effect of relative social status, cost of not challenging/monitoring, and authoritarianism on the challenging/monitoring communications behavior of subordinates in a cockpit environment?

Status and Cost of Not Challenging/Monitoring

The effects of status and cost of not challenging/monitoring on the communications behavior of subjects can be explained best by discussing the significant interaction found between them. Following a discussion of this interaction, the effectiveness of the manipulations used for these variables will be discussed.

The statistical analyses showed the status by cost of not challenging/monitoring interaction to be significant in determining the challenging/monitoring communications behavior of subjects. The nature of this interaction does not support the hypothesized interaction between these variables, and provides only partial support for the hypothesized effect of the cost of not challenging/monitoring variable. It was believed that copilots would be more aggressive in their challenging/monitoring communications behavior in the high cost of not challenging/monitoring condition for both status conditions. But, this effect would be more dramatic in the high than low status condition. In other words, the cost of not challenging/monitoring manipulation would influence the aggressiveness of the subject more when he/she was paired with a high status pilot.

It was believed that in the low status condition, the subject would display a high degree of aggressiveness with or without the cost manipulation. Because of this, a ceiling effect would occur - the subject can only be so aggressive. Therefore, the cost manipulation would not have as large of an effect. In the high status case, the subjects' aggressiveness would be low due to status effects. Once the cost manipulation is introduced, there is ample opportunity for the subject to increase his/her degree of aggressiveness. Another way of expressing this hypothesized relationship is to look at the differences in aggressiveness across status conditions in each of the cost of not challenging/monitoring conditions. In terms of aggressiveness, a larger difference between status conditions in the low cost condition than in the high cost condition was predicted.

The results display a different relationship, however. Instead of diminishing the effects of status as predicted, an increase in the cost of not challenging/monitoring variable served to accentuate the difference. No significant difference was noted in communications behavior between copilots paired with low and high status pilots when the cost of not challenging/monitoring was low. However, a significant difference was found when the cost of not challenging/monitoring was high, with those paired with high status pilots being less aggressive. Figures 1 and 2 display this interaction with regards to the number of communications and timing of first input variable. Figure 3 lends support for this interaction, but is only descriptive in nature.

In the low status condition, the hypothesized relationship was, for the most part, supported - subjects were more aggressive in the high than low cost of not challenging/monitoring condition. This was true for the timing of first input variable and supported by the types of communications data, while the number of inputs data did not reflect this. The departure from the hypotheses appears to be embodied in the behavior of subjects paired with high status pilots. When subjects were paired with high status pilots, they were more aggressive in the low than high cost of not challenging/monitoring condition. They provided more and earlier inputs to high status pilots when the cost of not challenging was low. Also, the pattern of results from the types of communications data is consistent with these findings.

To the extent that the status differential found in cockpits closely resembles that represented in the low status condition of this research, the situation would be advantageous in terms of safety. Copilots paired with low status pilots would be more aggressive in their challenging/monitoring communications behavior as the cost of not doing so increased. However, it is believed that the status differential common to cockpits is more accurately represented by the high status condition of this research. These findings imply that when a copilot is paired with a high status pilot who makes a serious mistake, he/she is least likely to be aggressive in challenging such an error. In other words, copilots are least likely to challenge their pilot when their input is most needed. The negative impact of such patterns of communication on performance and safety has been demonstrated by other researchers (NTSB, 1994; Smith, 1979; Foushee and Manos, 1981; Foushee et al., 1986).

These findings appear to parallel those found by Foushee et al. (1986). These researchers measured the quantity and types of communications made by pilots and first officers in a high fidelity simulation experiment. They also measured the quantity and types of errors, along with the degree of familiarity between crew members.

There were two degrees of familiarity in their study. Familiar crews were ones that had flown together in their last duty cycle, while unfamiliar crews had not. Their results showed that familiar crews communicated more and performed better than unfamiliar crews. Captains and first officers on familiar crews issued more commands, made more suggestions, and made more statements of intent than crews comprised of individuals unfamiliar with one another. Also, first officers who were more familiar with their captains expressed more disagreement.

For their error analysis, they placed errors into three categories, based on consequences to flight safety. Type I errors were minor and determined to have a low probability of serious consequence. Type II errors were moderate in terms of potential for safety consequences. Type III errors were determined to be severe and having a direct impact on safety. In examining their results, these researchers found no significant difference between the incidence of Type I errors based on familiarity. However, there was a significant difference between the incidence of Type II and III errors depending on degree of familiarity. Familiar crews were less likely than unfamiliar crews to commit these more severe errors. No direct statistical analysis was applied to examine the effect of familiarity across error types; however, from the pattern of results, the effect of familiarity on error occurrence appears to increase with the severity of the error. With regards to familiarity, no significant difference was present for Type I errors, a moderately significant difference was noted for Type II errors, and a highly significant difference was observed for Type III errors. In other words, as the potential consequences associated with the error increased, the difference between error occurrence for familiar and unfamiliar crews became greater.

The findings from the research reported on here are very similar, and provide for a possible explanation of the pattern of error occurrence noted in the Foushee et al. (1986) study. In the research reported here, the copilots were least aggressive when the pilot was of high status and the consequences associated with errors were high. The Foushee et al.

error occurrence data implies a relationship between consequences of error and familiarity. The more severe the consequences the greater the impact of familiarity, with unfamiliar crews committing a significantly greater number of severe errors than familiar crews. Perhaps, this pattern of error occurrence is the result of first officers who were unfamiliar with their pilots being less aggressive in their challenging/monitoring communications behavior than those paired with a familiar pilot. In other words, the pattern of error occurrence was not a result of general differences in communications behavior, but due more specifically to differences in the challenging/monitoring communications behavior of the first officers. Also, it appears that familiarity in the Foushee et al. (1986) study and status in this research have similar impacts on communications behavior, which implies that they share a common underlying process.

Such observations are speculative in nature, but provide the needed impetus for further research. Such research is required to explain the underlying psycho-social mechanisms causing the interaction between status and cost of not challenging/monitoring variables. One theory that provides partial support for this interaction is the Theory of Politeness proposed by Brown and Levinson (1987).

Being polite means taking the feelings of others into account when acting. In being polite, one acts in a more complicated and less direct fashion than otherwise would occur (Brown, 1990). Two kinds of feelings are entertained in this theory - those associated with positive face and those associated with negative face. Positive face refers to the wish of individuals to be approved of, while negative face refers to the wish to be free from imposition. According to Politeness Theory, the verbal strategy that one chooses in an interaction is determined by the degree of estimated risk of face loss. Risk of face loss increases with the social distance between the individuals, the power the receiver has over the speaker, and as the risk of imposition increases. When the estimation of risk of face loss is low, a more bold and direct form of communication strategy will be used. When the estimation of risk of face loss is high, a more inefficient strategy may be taken. This may include no communication occurring between individuals, stating things off the record, or stating things in an apologetic manner (Brown, 1990).

Within the high status condition, subjects may have been less aggressive in the high cost than low cost condition, because it posed a more serious threat to the face of the pilot. In other words, the weightiness of them pointing out a pilot's mistake is significantly more when the cost of the error is high. The risk of imposition is higher, resulting in the choice of a less direct form of communication or the lack of communication. This is a convenient explanation for the effect of cost of not challenging/monitoring for those in the high status condition, but fails to explain the increase in aggressiveness displayed by those in the low status condition. According to Politeness Theory, copilots in the low status condition should also show a decrease in aggressiveness as cost of not challenging/monitoring increases. Perhaps these findings highlight an operational boundary for the applicability of Politeness Theory. It is possible that Politeness Theory cannot be used to predict verbal strategies of actors in conditions where no large status differences exist and external reward/punishment structures are present. In nearly equal status conditions, the motivations associated with attainment of rewards or avoidance of punishment overrides any consideration for the feelings of others. An alternative explanation is that there is an interaction between risk of imposition and status differential within Politeness Theory. More research is needed to clarify this point and to explain fully the interaction discovered in this research.

Such factors as politeness may also shed light on the general reluctance of the subjects to communicate to the pilots regarding the task. The data revealed that 15% of the subjects provided no inputs and less than 20% provided at least one input prior to the assigned heading/altitude. Even more astonishing was the finding that less than 7% of the maneuvers in which a communication was appropriate involved a task relevant communication from the copilot and directed at the pilot. This occurred in spite of the training which emphasized the importance for them to monitor the pilots performance, interact with the pilot, and as a teammate, help him in the execution of the profile. This general reluctance is consistent with NTSB findings and past aviation safety reports (Foushee and Helmreich, 1988).

The reluctance of the subjects in this research may have been due to the experimental task not engaging the subjects, the subjects not being adequately trained to accomplish the monitoring task, or the subjects not taking their participation in the research serious. However, after evaluating the training regimen and reflecting on the general reactions of the subjects during the debriefing, it is unlikely that such reluctance was the result of experimental effects. Politeness Theory may provide a more plausible explanation for these findings. It may be that communicating to someone regarding their performance is in and of itself a face threatening act. Providing inputs to the pilot may be viewed as an imposition on the pilot to exercise his/her own will. This would result in a greater risk of face loss and the use of more indirect forms or lack of communication.

The significant simple correlations between status and the three communication variables, along with the significant main effect for status were overshadowed by the interaction between status and cost of not challenging/monitoring. This leads one to question the stability of status effects, as predicted by Status Characteristics Theory. These research findings imply that any effects due to status can be significantly moderated through the use of subtle incentives. So, any examination of status effects in an organizational context must take into account the environmental reinforcers involved to accurately predict behavior.

These research findings provide support for the effectiveness of the status manipulation used. However, the results of the status manipulation checks from the post-simulation questionnaire are not completely consistent with these behavioral results. The two questions of the post-simulation questionnaire designed to check the status manipulation produced conflicting results. One question was designed to see if the population of subjects, as a whole, believed the social status of a military officer to be above that of a college student. The results from this question showed that, in general, the subjects rated military officers as possessing a higher degree of social status than college students. This finding lends support for the status manipulation used.

However, some divergence of status ratings from behavior is evident from the results of the other question designed to check the status manipulation. For this question, subjects were asked to rate the status of the pilot they worked with. Subjects paired with high status pilots rated their partner no higher than subjects paired with low status pilots.

There are several potential explanations for this equality in ratings across status conditions. One possibility is that in the low status condition, the subjects took the age of the pilot and marital status (the pilot wore his wedding ring during the sessions) into account in providing their rating of social status. In the high status condition, age and marital status may have been replaced by skill as a military pilot, leading to no appreciable increase in social status ratings. During the simulation, the low status subjects may not have been affected in the same manner as high status subjects, due to differences in the status cues associated with each of the conditions. Age and marital status are more diffuse in nature, while experience as a pilot are more specific to the task. Social desirability may have been a factor as well. Subjects may have been reluctant to rate the low status pilot low in social status, just out of courtesy and politeness.

The nature of the status by cost of not challenging/monitoring interaction explains why the simple correlations between cost of not challenging/monitoring and the dependent variables were not found to be significant. The divergence in behavior (low status subjects becoming more aggressive with an increase in cost, while high status subjects becoming less aggressive) resulted in a null overall relationship with the communication variables. The interaction displays that cost was important in determining challenging/monitoring behavior, but only in the context of status.

The effect of the cost of not challenging/monitoring in qualifying the status effect is especially noteworthy when one entertains the subtle nature of the cost manipulation. The subjects were not faced with losing $50; they were faced with losing a 1 in 80 chance at $50. This finding implies that the effect of status on challenging/monitoring behavior is especially sensitive to the costs involved. Further research is needed to more specifically define the boundaries and nature of this sensitivity. Were the cash prize worth $1000, the nature of the resulting interaction (if any) may be significantly different from the one found here.

Three questions of the post-simulation questionnaire were used to assess the effectiveness of the cost manipulation. Subjects in the low cost condition rated the importance of avoiding a mid-air collision and following ATC instructions at the same level as those in the high cost condition. Also, the possibility of losing the chance at the cash prize did not motivate the high cost subjects to communicate more than the low cost subjects, according to their responses. However, in just the low status case, the high cost subjects did report that they were more motivated to communicate than the low cost subjects.

With the exception of this last finding, the overall effectiveness of the cost manipulation, according to the responses to the questionnaire items, could be judged as poor. However, the manipulation was effective enough to elicit a change in behavior, as noted from the significant interaction between status and cost. The effect of the manipulation appears to have been too subtle for it to be expressed by the subjects in the answering of questionnaire items, but strong enough to impact behavior.

There are several possible explanations for this disparity. Social desirability may have been a factor in the subjects responding to the questionnaire items. The training regimen emphasized the importance for them to take their role as copilot serious throughout the simulation. With the simulation complete, the subjects may have wanted to provide evidence to the experimenter that they took their role serious. In such cases, all subjects would report that it was important for them to follow ATC guidance and avoid a mid-air collision, regardless of the cost condition they were in. Also, it may have been difficult for any of the subjects to respond that it was not important to follow ATC guidance and avoid a mid-air collision out of a fear of appearing unintelligent. It would be more natural for all subjects to respond that it was important to accomplish these things regardless of the condition. Such speculation leads one to question the usefulness of the questions as they were written in checking the cost of not challenging/monitoring manipulation. Also, the question regarding their motivation to communicate only asked if the possibility of losing the cash prize motivated them to communicate more with the pilot. It did not ask if it motivated them to communicate less, as happened in the high status condition. Finally, it may merely reflect an inherent divergence of reported attitude from behavior. Individuals may not be willing or able to accurately report the level of importance they place on things, even when variations in their behavior are apparent.

Authoritarianism

The two hypotheses not addressed thus far deal with the effect of authoritarianism on an individual's challenging/monitoring communications behavior. It was predicted that high authoritarian subjects would be more aggressive in their communications behavior than low authoritarians. This prediction was based on the definition of authoritarianism provided by Altemeyer (1981) and past research in other settings. This prediction was not supported by this research.

The second prediction addressed a possible interaction between authoritarianism and status. From passed research in other settings, it was believed that high authoritarian copilots would be more aggressive with low status than high status pilots. Low authoritarians were predicted not to be more aggressive with low than high status pilots. The regression analyses conducted on this data did not support this prediction.

The failure of this variable to have a significant effect in this research may be due to situational factors. In previous research in which authoritarianism was significant, the situations may have been more conducive to the display of authoritarian type behavior. In the Milgram type situation, individuals are put in direct control of punishment and are reinforced by an authoritative figure for their administration of punishment. Such situations match well with the definition of an authoritarian provided by Altemeyer (1981). The subject submits to the legitimate authority (experimenter) involved, and displays aggression towards others which is sanctioned by this authority figure.

Other research settings have put subjects in control of deciding the punishment that criminals should receive for their crimes. In such situations, the subject reads an experimentally produced description of the crime and accused individual. The subject then provides a recommended punishment. This situation, like the Milgram type research, matches well with the authoritarian definition. It provides a legitimate and endorsed justification in the form of the law in assigning harsh penalties to criminals, especially low status criminals.

A weak match between the situation used in this research and the authoritarian definition may account for its insignificance. The individuals in this situation were trained on what must be accomplished and what is expected of him/her. They were then left on their own to execute these instructions without direct oversight by the confederate. The confederate left the role of experimenter and became part of the simulation. Altemeyer (personal communication, May 22, 1996) notes that high authoritarians can be considered cowards in many situations. This situation may have allowed them to display their cowardice, rather than their aggression. In the absence of an authority figure, they failed to display aggression which would otherwise be expressed. No legitimate authority was present to reinforce the use of aggression. Another explanation is that the endorsement of aggression was too weak for it to be displayed. The individuals failed to perceive the confederate and training protocol as an established and legitimate entity, leading to a lack of display of aggressiveness towards the pilot.

The analysis of the RWA provided impressive results, however. With a coefficient alpha of .918 it is difficult to argue that the RWA is measuring something more or different than that intended by its creator.

Other Analyses

The method used to code the communications data proved to be reliable. Test-retest correlations of 1.0 and inter-rater correlations ranging from .841 to .992 provide support. Such high reliability coefficients may be due to the simplicity of the coding task. For the timing of first input variable, coders merely had to start and stop a stop-watch at appropriate times. For the number of inputs variable, they were tasked with simply counting the number of inputs provided by the subject. The protocol appeared to be useful in discriminating between separate communications. For the types of communication variable, greater variance in inter-rater data led to lower, yet acceptable reliability coefficients. This was expected, given the nature of the task in which coders had to use some judgment in classifying communications.

Sex, age, familiarity with flying, and familiarity with flight simulation games were measured and analyzed. This was accomplished in order to examine their contribution, if any, to the variance in communications behavior observed. However, since they were not the primary variables of interest, no manipulations or predictions were made. None of these variables proved to be significant in terms of predicting the communications behavior of the subjects. This provides support for the proposition that such variables did not influence the results.

Recommendations for Further Research

As in any research conducted in a laboratory setting, the generalization of these results to a real cockpit setting may be questioned. College undergraduates involved in a personal computer based flight simulation game is not the same as qualified pilots executing their flights in an aircraft. Other researchers have used such populations and games to evaluate crew resource management training (Baker, Prince, Shrestha, Oser, and Salas, 1993) and in research examining the effects of cross-training on team functioning (Volpe et al., 1996). But, these researchers also raised questions as to the generalizability of their results. However, the similarity in findings between the high fidelity simulation used in the Foushee et al. (1986) study and this research supports the generalizability of these results. Further research is needed to demonstrate the generalizability of these findings across various levels of fidelity.

While the transfer of the relationships demonstrated in this research may be questioned, the task the subjects accomplished is realistic. It kept the subject involved in typical duties and responsibilities which are carried out by copilots in the airlines and military. Also, the variables examined are basic psychological and social constructs whose relationships are more likely to span across different contexts. Such results could be used outside the aviation context and applied to other instances where two people work together on a common task, as in many process control tasks or in the health care profession.

Another limitation of this research concerns the relationship between the copilot and pilot, and the cost of not challenging/monitoring variable. In both military and civilian aviation, the pilot possesses some authority and power over the other crew members. Power and authority were not directly manipulated in this research, only status. Similar research may be necessary to examine the influence of power on the relationships examined in this experiment. Such research would essentially test the cost of challenging/monitoring, as opposed to the cost of not challenging/monitoring the performance of the pilot as examined in this research.

In a real cockpit situation, there are costs associated with challenging and costs associated with not challenging the performance of others. Costs associated with challenging the pilot may come in the form of social ostracization from the crew or the pilot filing a negative report on the individual's performance. A subordinate may be especially vulnerable to such outcomes during probationary periods of employment. The costs associated with not challenging may not always come in the form of financial loss.

Risk of losing one's life or threatening the lives of others, along with the risk of losing one's job and social status in the community may also be salient to the individual.

This research did demonstrate that subtle changes in these costs can cause significant changes in behavior to occur. Perhaps other research using real crew members can be conducted to determine the specific costs associated with challenging and not challenging the performance of others in the cockpit. These costs can then be pitted against one another across a variety of situations to determine their overall impact.

Authoritarianism was not found to be useful in the prediction of challenging/monitoring communications behavior of copilots. However, this does not mean that personality variables are not important with regards to team functioning and the demonstration of effective challenging/monitoring behavior. Selection criteria for pilots have been influenced by the traditional stereotype of a pilot. At the outset of aviation when dangers and risks were much higher than today, a pilot was seen as the rugged, fearless individualist willing to take chances. Such a stereotype was ingrained in the aviation culture and influences pilot selection criteria. This dominates in spite of the routine nature of flight operations today, the excellent safety record commercial aviation has compared to other forms of transportation, and the almost exclusive use of multi-place/crew aircraft in commercial aviation (Foushee et al., 1988).

Most pilots in commercial aviation today come from single-seat military aviation backgrounds. Such experience provides testimony to their technical flying skills, but says nothing of their ability to function as a team member in a multi-place aircraft. Training appears to be the predominant method used to rectify this disparity (Foushee et al., 1988).

For the future, it is recommended that more research on personality factors which are conducive to flight crew performance and team functioning be accomplished. Results from such work can be used to identify individuals who possess characteristics which are conducive to group functioning in the cockpit. This can be used in conjunction with technical flying ability in the selection of pilots into multi-place aircraft.

Other factors are sure to exist which influence a copilot's challenging/monitoring behavior. But, in the least, the research conducted here provides a foundation for further examination of the influential variables involved and the possible use of similar, relatively inexpensive experimental methods.

Summary

This research served to narrow our understanding and definition of the challenging/monitoring problem in the cockpit. It showed that there is a qualitative, quantitative, and temporal difference in communications provided by copilots in a cockpit setting depending on the status of the pilot and cost of not challenging/monitoring the pilots performance. The combination of these two factors explained over 25% of the variance in the challenging/monitoring communications behavior of the copilots. The most dangerous situation identified in this research is when a copilot is paired with a high status pilot, and the consequences of the mistakes made by the pilot are the greatest. In other words, the copilot is least aggressive with high status pilots who make errors which are likely to cost the most.

These findings suggest that operational procedures and training programs should be modeled so as to decrease the effects of status. Also, since the high status condition in this research is thought to more closely resemble the status differential found in operational cockpits, subordinates need to understand that their challenging/monitoring behavior can be negatively impacted by the costs associated with errors. Incorporation of these findings into the assertiveness training components of crew resource management training programs may be useful.

Further research is needed to demonstrate the stability of these findings across varying contexts, and to define the conditions under which the strong interaction between status and cost of not challenging/monitoring found in this research is evident.

APPENDICES

Appendix A

Simulation Phase Outline

This information serves as guidance for the confederate in accomplishing the necessary tasks during the simulation phase of the experiment. It covers the introduction of the pilot (experimenter) to the subject, the team interphone practice session, and the starting and termination of the flight profile.

Following the accomplishment of the practice session with the subject, leave the room and retrieve the confederate. One of two scripts is used in introducing the confederate to the subject, depending on the status condition the subject is assigned to.

For the high status condition, the introduction should be made in the following manner:

> "(Subject's name) this is Sean Carey. He will be the pilot you are going to work with in accomplishing the flight profile. He is a pilot for the Air Force with over 2500 hours of flying time, who is also helping us in this research."

For the low status condition, the introduction should be made in this manner:

> "(Subject's name) this is Sean Carey. He will be the pilot you are going to work with in accomplishing the flight profile. He is a fellow student here at Clemson who has some experience with computer simulations, who is also helping us in this research."

Once the introduction is complete and the two have shaken hands, tell them to be seated and put on their headsets. You will then lead them through a brief team interphone practice session. Ask the team to make the appropriate calls over the interphone system in response to the following ATC instructions that you read to them (use the appropriate call sign number in place of the ** below):

1. Tiger **, you are cleared for takeoff. Climb and maintain 9000 feet and maintain runway heading.
2. Tiger **, say airspeed.
3. Tiger **, turn left heading 260.
4. Tiger **, climb and maintain 15,000 feet.
5. Tiger**, say transponder setting.

Check to make sure that the communications of the copilot are proficient according to the training that was conducted. Provide remedial training as necessary.

Next, take the following actions to begin the session:

1. Tell the subjects: "The session will begin after I leave the room and when you hear the first ATC instruction over the headphones. Turn

the pause function of the program off following the first ATC instruction."

2. Show them how to turn off the pause function (press "p" on the keyboard).
3. Turn up the volume on the speakers to the 2 o'clock position.
4. Start the video camera recording function and check for the desired picture. Press the record button on the VCR.
5. Leave the room and start transmitting the ATC instructions, following the profile and timing outlined in Table D1. Start the timer when the pilot depresses the "p" key to take the program off pause. Be ready at any time to repeat instructions over the interphone system.

Table A-I. Experimentally produced flight profile.

Number	ATC Instructions	Parameter	Comply / Not Comply
1	Tiger **, you are cleared for takeoff. Climb and maintain 13,000 feet and maintain runway heading.	altitude	Comply
2	Tiger **, turn right heading 080.	heading	Comply
3	Tiger **, say airspeed.	airspeed	Not Applicable
4	Tiger **, turn left heading 340.	heading	Not Comply
5	Tiger **, descend and maintain 9,000 feet.	altitude	Comply
6	Tiger **, say transponder setting.	transponder	Not Applicable
7	Tiger **, climb and maintain 14,000 feet.	altitude	Not Comply
8	Tiger **, say airspeed.	airspeed	Not Applicable
9	Tiger **, turn left heading 200.	heading	Comply
10	Tiger **, descend and maintain 10,000 feet.	altitude	Not Comply
11	Tiger **, turn right heading 270.	heading	Not Comply
12	Tiger **, say airspeed.	airspeed	Not Applicable
13	Tiger **, turn right heading 350.	heading	Comply
14	Tiger **, say transponder setting.	transponder	Not Applicable
15	Tiger **, descend and maintain 7,000 feet.	altitude	Comply
16	Tiger **, turn left heading 210.	heading	Not Comply
17	Tiger **, climb and maintain 11,000 feet.	altitude	Not Comply
18	Tiger **, say airpeed.	airspeed	Not Applicable

Once the last maneuver is complete:

1. Return to the simulation room.
2. Inform them that the exercise is complete.
3. Have them pause the program.
4. Turn off the recording function on the video camera and vcr.
5. Thank both for their participation and ask the pilot to leave.
6. Begin the post-simulation phase.

Appendix B

Protocol for Coding Communications

Timing of Communications

A stopwatch will be used to code the timing of the first communication made by the copilot and directed at the pilot, with regards to the change in altitude or heading dictated by air traffic control. The smallest interval coded is in hundredths of a second. The time will be coded as negative if provided prior to the assigned heading or altitude, and positive if provided after the assigned heading or altitude. Timing begins when the copilot begins speaking to the pilot, not when the microphone is keyed. *Non-task* and *mistake* type communications will not be used to determine timing of first input (see below for an explanation of types of communications) . If no communication is provided by the copilot with regards to the change dictated by air traffic control, the coder will annotate the following times:

Action Number	Timing
4	+25.73
5	0
7	+30.50
9	0
10	+24.66
11	+22.72
13	0
15	0
16	+22.84
17	+24.03

Number of Communications

The number of communications made by the copilot and directed at the pilot with regards to the heading or altitude change dictated by air traffic control will be determined. A continuous speech stream with several inputs will be considered one communication for coding purposes. The communication will be considered complete/distinct when the individual concludes his/her message or turns off his/her microphone switch. Should the individual not turn off his/her microphone switch, but comes to a conclusion of his/her message, the communication will be determined to be distinct and separate from any subsequent communication.

Only those communications classified as *directive*, *information/observation*, or *inquiry* will be included in this count. *Non-task* and *mistake* type communications will be determined and annotated, but not be included in determining the number of communications made by the copilot. An explanation of these categories of communication follows.

Determining the Type of Communication

All communications made by the copilot and directed at the pilot with regards to the heading or altitude change dictated by air traffic control will be coded into the following categories:

DIRECTIVE	Communication telling or asking the other member to do or take responsibility for a specific task. For example: "Turn back to a heading of 310 degrees", "Maintain 210 pilot", or "Let's stay at 11,000 feet pilot".
INFORMATION/ OBSERVATION	Communication that gives the other member information about what the speaker has done or intends to do to the aircraft, recognition of a task-related fact, or communication about something that is occurring. For example: "We just passed our assigned heading", "We are approaching our assigned altitude", "Pilot, 14,000 feet", or "We need to go to 210 pilot".
INQUIRY	Communication in which one member asks for specific, factual information from the other member. For example: "What altitude were we assigned by air traffic control?" or "Did we just pass our assigned heading?"
NON-TASK	Communication which is unintelligible or unclassifiable with respect to the present coding scheme.
MISTAKE	Communication resulting from an error made by the member and subsequently acknowledged as such by the member. For example: If the copilot states, "9,000 feet pilot" as the team passes 10,000 feet and then subsequently says "Never mind".

Should the member produce a continuous speech stream with information/observation or inquiry components, along with a directive component, the coder will code it as being a directive communication. In other words, the coder will error to the hardest form of communication present, with directive being the hardest and inquiry being the softest. For example, if the member says, "210 pilot, turn left", the correct coding of this message would be directive.

This categorization of communications is based on previous research conducted by Fjelde (1992).

Appendix C

Laboratory Handout for the Copilot

Thank you for your participation in this research. Your involvement is necessary for the advancement and testing of scientific theory and principles. Please carefully read the following information regarding your role and responsibilities in the research you are participating in.

For this research, you will take on the role of copilot in the accomplishment of a flight profile with another research participant who will be acting as pilot. This will be accomplished on a personal computer, using Microsoft Flight Simulator (Artwick, 1995) software. The activities you will be involved in can be broken into three phases - the training phase, the simulation phase, and post-simulation phase. The following information outlines these activities and their order of accomplishment:

1. Training Phase
   - (a) Training Video

     This video will instruct you on how to fulfill the duties of a copilot in flying the personal computer game Microsoft Flight Simulator (Artwick, 1995).
   - (b) Practice Session

     This session will allow you to practice those duties learned through viewing the training video. You will also be given instruction on how to operate the interphone system.

2. Simulation Phase
   - (a) Meet Fellow Research Participant (Pilot)
   - (b) Team Interphone Practice
   - (c) Begin flight profile. You and the pilot are expected to fly a flight profile as directed by air traffic control (ATC). You are to fulfill the responsibilities of copilot during this phase.

3. Post-Simulation Phase

   During this phase, you will accomplish additional paperwork required by the research and be debriefed as to the nature of the research.

The training video sets forth the duties and responsibilities of the copilot position. It is important that you follow the guidance provided by the video in the conduct of your job. The duties of the pilot and copilot are set forth in Table A1 and will be reviewed in the video.

Table C-I. Duties of the pilot and copilot.

Pilot	Copilot
Controls heading.	Communicates with air traffic control.
Controls altitude.	Advises pilot of air traffic control assigned headings, altitudes, and airspeeds.
Controls airspeed.	Monitors all flight parameters (heading, altitude and airspeed)

Please take your role as copilot serious. We hope you will conduct yourself as you would in a real aircraft cockpit. (Note: The following information is included in the instruction sheet for the high cost of not challenging/monitoring condition only. The low cost of not challenging/monitoring subjects will not receive this information. As noted in the body of the proposal, there is no chance of colliding mid-air with other air traffic, so all participants have an equal chance of winning the $50 cash prize.) We would like you to act as though you are a copilot on an airline flight carrying hundreds of passengers. Your opportunity for winning the $50 cash prize is predicated on one condition. There is a danger of colliding mid-air with other air traffic if not complying with air traffic control instructions. Should you collide with another aircraft due to not adhering to air traffic control instructions, you sacrifice all possibility of receiving the cash prize. In other words, adherence to air traffic control instructions is important if you want a chance at winning the $50.

The purpose of this form is to help the copilot in communicating with air traffic control and the pilot. Blanks are provided and should be filled in as necessary to accomplish radio and interphone transmissions.

Cleared for Takeoff

ATC:	Tiger **, you are cleared for takeoff, climb and maintain ___________feet and maintain runway heading.
Copilot to ATC:	Roger, Tiger **, cleared for takeoff, climb and maintain ___________feet and maintain runway heading.
Copilot to Pilot:	Pilot, we are cleared for takeoff, climb and maintain ___________feet and maintain runway heading.

Change in Heading

ATC:	Tiger **, turn right/left heading _____.
Copilot to ATC:	Roger, Tiger ** turning right/left to heading ______.
Copilot to Pilot:	Pilot, we are cleared right/left to a heading of _____.

Change in Altitude

ATC:	Tiger **, descend/climb and maintain __________feet.
Copilot to ATC:	Tiger **, cleared to __________feet.
Copilot to Pilot:	Pilot, we are cleared to __________feet.

Request for Airspeed

ATC:	Tiger **, say airspeed.
Copilot to ATC:	Tiger** ________knots indicated airspeed.
ATC:	Roger, Tiger **.

Request for Transponder Setting

ATC:	Tiger**, say transponder setting.
Copilot to ATC:	Tiger**, ________ in the transponder.
ATC:	Roger, Tiger**.

Appendix D

Training Phase Outline

The following information serves as a guide to the experimenter in accomplishing all of the tasks during the training phase. The areas covered include the training video and the practice session.

Experimenter to subject: "To begin the training phase, I would like you to watch a training video that is approximately 15 minutes in length. It provides detailed information regarding your role and responsibilities, and information on how to operate the interphone system. Do not hesitate to pause the video and get my attention should you run into any problems or have any questions. Once the video is complete, turn off the power to the television and wait for me to return."

The following steps serve as a checklist for you to follow prior to and after departing the room:

1. Make sure the program is running and visible on the monitor.
2. Make sure the interphone system is powered and headsets are available.
3. Show the subject how to pause the video player and turn off the television.
4. Tell the subject where you will be during the video.
5. Start the video and note the time when you should return.
6. Log all subject data on the data collection sheet, and prepare the video camera for recording.

Upon returning to the room, ask the subject if they have any questions regarding any information that was presented on the video. Once all questions (if any) have been answered, lead the subject through the practice session. The following script will be followed in accomplishing the practice session:

1. You and the subject put on your headsets.
2. Test the interphone system by pressing the microphone switch and asking the subject if he/she can hear you. Make sure the subject responds over the interphone.
3. Over interphone, tell the subject:

   I will be leading us through a scripted practice session. Our call sign for this practice session is Tiger **. I will be acting as air traffic control for this practice session and will use my interphone to provide instructions. I want you to respond to these calls as if I were air traffic control. Follow those procedures you learned during the training video.

   You and the pilot are to act as a team in accomplishing the profile. The pilot did not make any mistakes in the video, so there was no need for the copilot to provide additional inputs to the pilot about his performance. But, if I make a mistake in this practice session or the pilot makes a mistake during the actual flight profile, you should let the pilot know he is making or has made a mistake. If the pilot is more than 100 feet off altitude or more than five degrees off heading, you should be informing him. Also, you can provide any additional inputs to the pilot to help him fly according to instructions given by air traffic control. For example, you could tell him when you are approaching an assigned heading or altitude, or repeat the ATC instructions to him at any time. In other words, don't be afraid to communicate task relevant information to the pilot. Remember, you should act as a team in accomplishing the flight profile.

Because the airspeed indicator is so sensitive, it may fluctuate throughout the session. Don't let this bother you. Are you ready to start?"

4. Once the subject is ready, start the program and follow this script:

You as ATC:	Tiger **, you are cleared for takeoff, climb and maintain 7000 feet and maintain runway heading.
Subject:	Roger, cleared for takeoff, climb and maintain 7000 feet and maintain runway heading.
Subject:	Pilot, we are cleared for takeoff, climb and maintain 7000 feet and maintain runway heading.
You as pilot:	Roger.
Action:	You and the copilot accomplish a takeoff and you fly the aircraft to 7000 feet and maintain the runway heading.
You as ATC:	Tiger **, turn right heading 090.
Subject:	Roger, Tiger ** turning right heading 090.
Subject:	Pilot, we are cleared to a heading of 090.
You as pilot:	Roger.
Action:	Turn the aircraft using 30 degrees of bank to a heading of 090.
You as ATC:	Tiger **, say airspeed.
Subject:	Tiger** ________knots indicated airspeed.
You as ATC:	Roger, Tiger**.
You as ATC:	Roger Tiger **, climb and maintain 10,000 feet.
Subject:	Roger, Tiger ** cleared to 10,000 feet.
Subject:	Pilot, we are cleared to 10,000 feet.
You as pilot:	Roger.
Action:	Climb the aircraft to 10,000 feet.
You as ATC:	Tiger **, say transponder setting.
Subject:	Tiger**, ________ in the transponder.
Action:	Pause the practice session. Provide feedback to the copilot regarding his/her performance. Ask him/her if they have any questions. If further practice is requested by the subject, take the simulation off pause and provide further instructions as ATC. Once the subject is proficient in accomplishing these

tasks, stop the simulation program and return it to the beginning screen.

5. Once proficiency is gained, take off the headsets and tell the subject:
   "This is the end of the practice session. Next, you will accomplish a flight profile similar to that we just accomplished with another research participant."
6. Have the subject take a break at this point. You can tell him/her that it is going to be about another hour before they will be done, so a trip to the bathroom/water fountain may not be a bad idea.
7. While they are on break, reconfigure the computer for video playback of the simulation ("sim5"). Make sure put the video on pause immediately and you drag the map over the lower left portion of the display to cover up "video".
8. After they return from break, or if they do not break, deviate their attention by having them fill out the drawing slip and blue card while you reconfigure the computer.
9. Take the training tape out of the vcr and put in the appropriate tape for recording the experimental session.
10. Leave the room and retrieve the pilot from the other room.

Appendix E

Training Video Outline

The following outline serves as a guide to the instructor who will appear on the training video tape for the copilot training session. In short, the instructor is to prescribe the duties and responsibilities of the subject in the experiment. Also, the video provides the subject examples of team behavior in carrying out flight duties.

I. Introduction

(a) Thank you for your participation. My name is Jason Gibson, and I will lead you through this training session.

(b) The purpose of this video is to teach research participants how to fulfill the duties and responsibilities of a copilot in the execution of a flight profile. The flight profile is determined through the instructions received from air traffic control (ATC).

(c) We will be covering different areas during the video, including:

- An introduction to Microsoft Flight Simulator (Artwick, 1995)
- A thorough examination of the interphone system and communications procedures
- Your duties and responsibilities as the copilot
- Example of a pilot/copilot team executing a flight profile.

II. Microsoft Flight Simulator 5.1 (Artwick, 1995)

(a) Lear jet simulation game.

Although we are using this personal computer based simulation for experimental purposes, we hope you will take your role serious. Please conduct yourself as you would in an actual cockpit as the copilot.

(b) Lets start out with the aircraft displays.

- Altimeter - The altimeter portrays aircraft altitude in thousands of feet. Provides both digital and analog altitude. We would like you to use the digital display as your primary reference for altitude.
- Heading - The aircraft's heading is from 0 to 360 degrees, just like a compass. The heading you see here is digital and is currently reading **** degrees.
- Airspeed - The airspeed indicator provides the speed of the aircraft in knots. Don't worry about the difference between knots and miles per hour. Since the analog portion of this display is slightly blurred, use the digital readout to reference your airspeed.
- Aircraft attitude - The attitude direction indicator provides a reference for pilots as to their position relative to the horizon. It is especially helpful for pilots when flying in clouds, because of

the lack of outside references to the horizon. You will see how this display portrays the aircraft's attitude shortly. The horizontal bars in the display indicate the difference in pitch of the aircraft relative to the horizon. The middle line represents the horizon. The markings arranged in somewhat of a circle in the top portion of the display indicate the bank angle of the aircraft during turns.

- Transponder - The transponder is a piece of equipment in the aircraft which sends a signal to air traffic control. Each aircraft can be identified by air traffic controllers by the code which is set in the transponder. During flight, pilots often have to report the four digit code set in the transponder.

(c) Show video of the aircraft being manipulated through a flight profile and what the displays are showing. Give a running narrative of the various displays as the aircraft is manipulated through the flight segment. Hit more heavily on the altimeter and heading indicator. Also, mention the transponder code setting and airspeed indicator.

III. Communications and the Interphone System

(a) The purpose of an interphone system is to communicate between air traffic control and the aircraft, and ensure communications between flight crew members (pilot and copilot in this case).

(b) The microphone is used to transmit to the pilot and air traffic control. The switch on the microphone is a basic on/off switch. To transmit, you should turn the microphone switch on, hold the microphone close to your lips, and talk. Once you are done talking, make sure you return the microphone switch to off.

(c) You receive information from air traffic control and the other pilot over the headphones. Also, you will hear yourself when you are transmitting over the system.

(d) Interphone procedures

Your laboratory handout spells out the minimum communications which should take place between you and the pilot, and you and air traffic control. This guide follows the same general rules:

- You must repeat instructions back to air traffic control and relay the information to the pilot. For instance, on the handout, you will see a portion which is for a change in heading. Air traffic control (ATC), may give you a change in heading, such as "Tiger 96, turn right heading 030". To this instruction, you turn on your microphone switch and respond "Roger, Tiger 96 turning right to heading 030". You then make another call to the pilot and say "Pilot, we are cleared right to a heading of 030". The pilot will respond to your call.

- You should use the interphone system in communicating with the pilot. In other words, don't turn to him and talk without using the microphone. There is too much noise in cockpits to talk directly to the pilot.
- Required communications are covered in the laboratory handout. This is the minimum. Do not hesitate to provide additional information to the pilot using the interphone system should it be necessary to insure safety.

(e) Refrain from irrelevant communications over the interphone system. In other words, you are a crew member in an aircraft accomplishing particular duties, so chit chat and socializing are not encouraged. However, as stated previously, don't hesitate to use the interphone system to provide relevant information to the pilot. You are an integral part of flight activities, not just an observer.

IV. Copilot Duties

(a) Refer to the table the subject received as part of their instructions.

(b) Pilot Duties

- Pilot controls all aspects of actually flying the aircraft.

(c) Copilot Duties

- Assists the pilot in the safe execution of a flight profile
- Communicates with air traffic control.
- Informs pilot of ATC instructions
- "Monitoring" not only involves vigilant examination of the aircraft displays, but also involves backing up the pilot should he make a mistake.
- These are your responsibilities - please take them seriously.

V. Example of a Pilot/Copilot Team

Now, we would like to demonstrate to you a pilot/copilot team executing a flight profile. Please pay attention to the communications made by the flight team and what the displays are reading. You will get an opportunity to practice these activities with the experimenter.

Appendix F

Post-Simulation Phase Outline

1. Accomplish the Right Wing Authoritarian measure.
2. Accomplish the questionnaire.
3. Debrief the subject.

   Important Note: The importance of a good debriefing cannot be overemphasized. The welfare of the research participants leaving the laboratory is the top priority. Extreme care must be taken to ensure that no research participant departs the laboratory under a state of stress, having negative thoughts regarding their performance, or harbors ill feelings toward the research community.

   (a) Purpose of the Experiment: The communications behavior of copilots has been shown to be different than that of pilots. Copilots have a tendency to be less aggressive in their communication behavior. Such hesitancy on the part of the copilot could lead to dire consequences should it occur during a critical phase of flight. The research you have just participated in examines some of the factors which may explain why copilots are less aggressive in their communication behavior. The factors examined in this research were status, authoritarianism of the individual, and cost of not challenging/monitoring the performance of the pilot.

   Past research and theory lead us to believe that individuals who are working on a task with a person of high status will not communicate as much as when working with individuals of low status. To test this idea, we are pairing half the subjects with persons of high status and half with persons of low status, and measuring their communication behavior. The number and timing of transmissions by the subjects and directed at the pilot are measured, and compared with the other status condition (low or high).

   The second variable we are examining is authoritarianism and its possible effect on communications behavior. One researcher, Bob Altemeyer (1981, p. 148) believes right-wing authoritarians can be characterized by three dominant characteristics:

   1. Authoritarian submission - a high degree of submission to the authorities who are perceived to be established and legitimate in the society in which one lives.
   2. Authoritarian aggression - general aggressiveness, directed against various persons, which is perceived to be sanctioned by established authorities.
   3. Conventionalism - a high degree of adherence to the social conventions which are perceived to be endorsed by society and its established authorities.

In order to measure this, Altemeyer developed the Right Wing Authoritarian (RWA) scale. It was the 30 item questionnaire you just completed. Past research in other settings indicates that those who score high on the RWA, display a higher degree of aggression than those who score low. Also, individuals scores have been shown to interact with status. For instance, some research has shown that those who score high on the RWA show more aggression toward low status individuals than high status individuals. Because of these research findings and the definition of authoritarianism provided by Altemeyer, this variable was included in the research. Also, no known application of this scale to copilot communications behavior research has been accomplished in the past.

The last variable manipulated in this research is cost of not challenging/monitoring the pilot's performance. Half the subjects in this experiment are told that their chance of winning the $50 cash prize is contingent on them not colliding with another aircraft. The other half are not told this. We believe that those in the high cost of not challenging/monitoring condition will be more aggressive in their communications behavior than those in the low cost of not challenging/monitoring condition. We are also interested in the possible interaction of this variable with the other variables (status and authoritarianism).

In order to examine the possible effects of these variables and measure your behavior, we will count the number of transmissions you made to the pilot regarding the change dictated by air traffic control. We are also going to examine when you provided your input to the pilot relative to the instruction given by air traffic control. For instance, when did you advise the pilot that he passed the assigned heading or altitude. The transmissions you made will also be coded qualitatively into categories.

(b) Deception used in the experiment: For ethical reasons, experimenters do not like to incorporate deception into their research. However, in some cases, deception has to be employed in order to examine the variables of interest.

Three deceptions were used in this experiment. First, those subjects in the high cost of not challenging/monitoring condition were told that their chance of winning the cash prize was predicated on them not hitting another aircraft. In actuality, there was no chance of hitting another aircraft in the simulation, so all research participants have an equal chance of winning the prize.

Second, the pilot in this experiment is actually the experimenter. He is a student at Clemson University and an active-duty Air Force officer with flying experience.

Third, the pilot was not actually flying the aircraft through the simulation. The flight simulation program was flying the aircraft, and the joystick was not plugged into the back of the computer.

(c) Justification for the use of deception: Strong justification is required when practicing deception when human subjects are used in research. We entertained alternative means of manipulating the variables involved in order to preclude the use of deception, but concluded that some minor deceptions are necessary to effectively examine the relationships of interest.

It is believed that a strong manipulation is necessary to get an effect for cost of not challenging/monitoring. For an actual copilot, factors such as physical well being, professional job status, and financial risk are highly valued. Such values influence the behavior of the copilot in enforcing standards because of perceived consequences. For this reason, the experimenter believes that a valued consequence of the subjects' behavior must be incorporated into the experiment. The most effective means of doing this is through the financial risk one takes if not complying with instructions. Risk of death or loss in stature are not seen as viable alternatives.

Approximately 40 subjects (half of the total subject pool of 80) are impacted by this deception. Of these subjects, all are lead to believe that the other research participants are operating under the same rule. In other words, they are not likely to think such a rule is unfair or that they have been singled out. Subjects are assigned to conditions based on random assignment. Also, in recruiting subjects, I tell them that their chance at winning the cash prize in contingent upon conditions set forth in the experiment.

The second deception is less obvious and not as direct. It is a matter of not telling the whole truth. The introduction of the pilot to the subject is important in this experiment. It is used to manipulate the status variable. The pilot is characterized as a "fellow research participant who also happens to be a student at Clemson" or a "fellow research participant who happens to be an Air Force pilot with over 2500 hours of flight experience" to the subjects. In actuality, he is the experimenter, not just a "fellow research participant". The experimenter was usedto portray the pilot in this experiment because of his status as a student and Air Force pilot. In this dual role, he could be introduced to the subject without lying. Alternative means of effectively manipulating this variable would most probably involve lying to the subject in the introduction of the pilot.

All of the approximately 80 subjects will be exposed to this deception. Its impact is expected to be minimal, with the benefit being great. The status variable is effectively manipulated, while deception is minimized. Subjects are not lied to, and its use is not expected to generate negative self-impressions, nor negative feelings toward the research community.

The last form of deception is that the subject is led to believe that the pilot is in control of the aircraft's altitude and heading. In actuality, the computer is in control of altitude and heading, with the pilot behaving as if he is in control. This deception is necessary to preclude the possible introduction of a confound into the experiment.

Variability in pilot performance may cause variance in the data collected. The pilot is expected to gain proficiency in flying the profile throughout experimental trials. In other words, his performance will be worst during the first few subjects and best during the last few. Standard climb rates and turn rates could be attempted by the pilot, but are not guaranteed. To preclude this variability in performance, the computer was given the task to fly the profile.

All of the approximately 80 subjects will be exposed to this deception. Again, its impact is expected to be minimal, with a substantial benefit. No other viable method of controlling for variability in pilot performance has been identified. No negative feelings should be generated by the subjects as a result of its use.

We appreciate your understanding. We hope that you do not leave this laboratory under any undue stress or harboring any ill feelings toward us or your performance, because of these deceptions. There is absolutely no reason why you should leave this laboratory with such feelings. Your participation contributes a great deal to our research efforts.

(d) Questions regarding their feelings:

Do you have any questions regarding the questionnaire or Right Wing Authoritarian scale? Do you have any bad feelings about the use of deception in this experiment? What, if anything, makes you feel uncomfortable about us deceiving you? Do you understand why deception was necessary?

(e) Date and location of the research results: The date my thesis will be posted will not be established until next semester. I hope to complete the thesis process by April 1, 1997. So, if you are interested in reading my thesis, go to the Psychology Department's conference room on the fourth floor of Brackett Hall in April of 1997.

(f) Date, time, and location of drawing for cash prize: Once data collection is completed, the drawing for the cash prize will be held. Data collection is expected to be completed no later than the end of February, 1997. One of the classrooms in Brackett Hall will be used to draw the name of the winning subject. You do not have to be present to win. No other specific information regarding the drawing can be given at this time. As soon as data collection is completed, I will post a notice outside my door (314 Brackett Hall) explaining the details of the drawing. Do not hesitate to call me to inquire about the drawing.

(g) Phone number and address of the experimenter:

Sean Carey
Psychology Department, Graduate Student
418 Brackett Hall
Box 341511
Clemson, SC 29634-1511

(h) Confidentiality: All data concerning your performance is kept confidential. In like manner, we would appreciate your assistance in keeping the details of this experiment confidential. Our research results would be invalidated should other research participants learn of the purpose and manipulations involved in this experiment. A subject's behavior will most probably change if they have this knowledge. Please maintain this confidentiality. If queried by others regarding the nature of the experiment, tell them that they will have to experience it themselves.

(i) Thank you for your participation. If you don't have any questions, you are free to leave.

Appendix G

Post Simulation Questionnaire

1. On the following scale, rate the general social status of your fellow research participant (pilot).

1	2	3	4	5	6	7
Extremely Low	Very Low	Low	Average	High	Very High	Extremely High

2. Rank order the following classifications from 1 to 7 in terms of relative social status. A rank of "1" is the highest social status, while a rank of 7 is the lowest.

______Accountant
______Engineer
______College Student
______Doctor
______Janitor
______Military Officer
______Professor

3. How important was it for you to fly the profile according to ATC instructions?

1	2	3	4	5	6	7
Not Important						Extremely Important

4. How important was it for you to avoid a mid-air collision in accomplishing the flight profile?

1	2	3	4	5	6	7
Not Important						Extremely Important

5. How would not complying with ATC instructions affect your chances of winning the $50 cash prize?

1	2	3	4	5	6	7
Not affect my chances at all.						Severely affect my chances of winning.

6. How would getting into a mid-air collision affect your chances of winning the $50 cash prize?

1	2	3	4	5	6	7
Not affect my chances at all.						Severely affect my chances of winning.

7. To what degree did the possibility of getting into a mid-air collision if off ATC assigned headings and altitudes motivate you to communicate more with the pilot.

1	2	3	4	5	6	7
Not Motivated At All						Extremely Motivated

8. Please rate your degree of familiarity with flying (excluding those times when you have been just a passenger).

1	2	3	4	5	6	7
Not Familiar At All						Extremely Familiar

9. Do you have a pilot's license, student's license, or any experience at the controls of an aircraft? ___Yes ___No

If you answered "yes", how many hours of flying time do you have? _____

10. Please rate your degree of familiarity with flight simulation computer games.

1	2	3	4	5	6	7
Not Familiar At All						Extremely Familiar

11. Please indicate your sex: ___Male ___Female
12. What is your age in years? ________
13. What is your academic major/area of interest:
    - ☐ My academic major/area of interest is:______________
    - ☐ I don't know what my major is or what it will be

Appendix H

Right Wing Authoritarian (RWA) Measure

This survey is part of an investigation of general public opinion concerning a variety of social issues. You will probably find that you agree with some of the statements, and disagree with others, to varying extents. Please indicate your reaction to each statement by blackening a bubble in Section 1 of the bubble sheet, according to the following scale:

Blacken the bubble labelled
-4 if you very strongly disagree with the statement.
-3 if you strongly disagree with the statement.
-2 if you moderately disagree with the statement.
-1 if you slightly disagree with the statement.

Blacken the bubble labelled
+1 if you slightly agree with the statement.
+2 if you moderately agree with the statement.
+3 if you strongly agree with the statement.
+4 if you very strongly agree with the statement.

If you feel exactly and precisely neutral about an item, blacken the "0" bubble.

You may find that you sometimes have different reactions to different parts of a statement. For example, you might very strongly disagree ("-4") with one idea in a statement, but slighlty agree ("+1") with another idea in the same item. When this happens, please combine your reactions, and write down how you feel "on balance" (i.e. "-3" in this case).

1. Life imprisonment is justified for certain crimes.

2. Women should have to promise to obey their husbands when they get married.

3. The established authorities in our country are usually smarter, better informed, and more competent than others are, and the people can rely upon them.

4. It is important to protect the rights of radicals and deviants in all ways.

5. Our country desperately needs a mighty leader who will do what has to be done to destroy the radical new ways and sinfulness that are ruining us.

6. Gays and lesbians are just as healthy and moral as anybody else.

7. Our country will be great if we honour the ways of our forefathers, do what the authorities tell us to do, and get rid of the "rotten apples" who are ruining everything.

8. Atheists and others who have rebelled against the established religions are no doubt every bit as good and virtuous as those who attend church regularly.

9. The <u>real</u> keys to the "good life" are obedience, discipline, and sticking to the straight and narrow.

10. A lot of our rules regarding modesty and sexual behavior are just customs which are not necessarily any better or holier than those which other people follow.

11. There are many radical, immoral people in our country today, who are trying to ruin it for their own godless purposes, whom the authorities should put out of action.

12. It is always better to trust the judgment of the proper authorities in government and religion than to listen to the noisy rabble-rousers in our society who are trying to create doubt in people's minds.

13. There is absolutely nothing wrong with nudist camps.

14. There is no "ONE right way to live life; everybody has to create their own way.

15. Our country will be destroyed someday if we do not smash the perversions eating away at our moral fibre and traditional beliefs.

16. Homosexuals and feminists should be praised for being brave enough to defy "traditional family values."

17. The situation in our country is getting so serious, the strongest methods would be justified if they eliminated the troublemakers and got us back to our path.

18. It may be considered old-fashioned by some, but having a normal, proper appearance is still the mark of a gentleman and, especially, a lady.

19. Everyone should have their own lifestyle, religious beliefs, and sexual preferences, even if it makes them different from everyone else.

20. A "woman's place" should be wherever she wants to be. The days when women are submissive to their husbands and social conventions belong strictly in the past.

21. What our country really needs is a strong, determined leader who will crush evil, and take us back to our true path.

22. People should pay less attention to the Bible and the other old traditional forms of religious guidance, and instead develop their own personal standards of what is moral and immoral.

23. The only way our country can get through the crisis ahead is to bet back to our traditional values, put some tough leaders in power, and silence the troublemakers spreading bad ideas.

24. Our country <u>needs</u> free thinkers who will have the courage to defy traditional ways, even if this upsets many people.

25. There is nothing wrong with premarital sexual intercourse.

26. It would be best for everyone if the proper authorities censored magazines so that people could not get their hands on trashy and disgusting material.

27. It is wonderful that young people today have greater freedom to protest against things they don't like, and to make their own "rules" to govern their behaviour.

28. What our country <u>really</u> needs, instead of more "civil rights," is a good stiff dose of law and order.

29. Some of the best people in our country are those who are challenging our government, criticizing religion, and ignoring the "normal way things are supposed to be done."

30. Obedience and respect for authority are the most important virtues children should learn.

31. Nobody should "stick to the straight and narrow." Instead, people should break loose and try out lots of different ideas and experiences.

32. Once our government leaders give us the "go ahead," it will be the duty of every patriotic citizen to help stomp out the rot that is poisoning our country from within.

33. We should treat protestors and radicals with open arms and open minds, since new ideas are the lifeblood of progressive change.

34. The facts on crime, sexual immorality, and the recent public disorders all show we have to crack down harder on deviant groups and troublemakers if we are going to save our moral standards and preserve law and order.

Appendix I

Descriptive Statistics for the Timing of First Input, Number of Inputs, and the Right Wing Authoritarian Scale

Table I-I. Descriptive statistics for the timing of inputs, number of inputs, and the Right Wing Authoritarian (RWA) scale.

Condition (number of cases)		Timing of First Input (seconds)	Number of Inputs	RWA
Overall (60)	range	-3.705 to 15.048	0 to 13	69 to 247
	mean	5.447	5.017	147.883
	s.d.	5.150	2.855	36.3
High Status (30)	range	-1.216 to 15.048	0 to 8	69 to 274
	mean	7.655	3.8	146.267
	s.d.	5.382	2.734	40.369
Low Status (30)	range	-3.705 to 15.048	0 to 13	90 to 231
	mean	3.239	6.233	149.5
	s.d.	3.862	2.459	32.338
High Cost (30)	range	-2.269 to 15.048	0 to 13	90 to 211
	mean	5.742	4.8	144.267
	s.d.	5.590	3.101	30.053
Low Cost (30)	range	-3.705 to 15.048	0 to 12	69 to 247
	mean	5.151	5.233	151.5
	s.d.	4.747	2.622	41.84
High Status-Low Cost (15)	range	-1.216 to 15.048	0 to 8	69 to 247
	mean	5.618	4.867	149.533
	s.d.	4.974	2.532	49.745
High Status-High Cost (15)	range	2.154 to 15.048	0 to 6	92 to 211
	mean	9.692	2.733	143
	s.d.	5.135	2.576	29.636
Low Status-Low Cost (15)	range	-3.705 to 15.048	0 to 12	92 to 231
	mean	4.685	5.6	153.467
	s.d.	4.634	2.746	33.814
Low Status-High Cost (15)	range	-2.269 to 5.372	5 to 13	90 to 192
	mean	1.793	6.867	145.533
	s.d.	2.221	2.031	31.45

Appendix J

Descriptive Statistics for the Post-Simulation Questionnaire Responses

Table J-I. Descriptive statistics for the post-simulation questionnaire responses.

Question Number	Question Content		Condition: Overall	High Cost	Low Cost	High Status	Low Status
1	status check	n	58	28	30	30	28
		range	2 - 7	4 - 7	2 - 7	3 - 7	2 - 7
		mean	5.052	5.143	4.967	5.267	4.821
		s.d.	1.050	0.970	1.129	0.868	1.188
2A	status check (military officer)	n	53	26	27	26	27
		range	1 - 7	1 - 7	2 - 7	1 - 7	2 - 7
		mean	4.340	4.462	4.222	4.308	4.370
		s.d.	1.493	1.476	1.528	1.436	1.573
2B	status check (college student)	n	53	26	27	26	27
		range	1 - 7	1 - 7	1 - 7	1 - 7	1 - 7
		mean	2.830	2.615	3.037	2.885	2.778
		s.d.	1.762	1.444	2.028	1.705	1.847
3	cost check	n	60	30	30	30	30
		range	4 - 7	4 - 7	5 - 7	5 - 7	4 - 7
		mean	6.383	6.467	6.300	6.367	6.400
		s.d.	0.825	0.860	0.794	0.890	0.770
4	cost check	n	60	30	30	30	30
		range	1 - 7	5 - 7	1 - 7	2 - 7	1 - 7
		mean	6.467	6.667	6.267	6.467	6.467
		s.d.	1.171	0.547	1.552	1.137	1.224
5	cost understanding	n	60	30	30	30	30
		range	1 - 7	1-7	1 - 7	1 - 7	1 - 7
		mean	4.283	6.100	2.467	3.833	4.733
		s.d.	2.538	1.398	2.080	2.705	2.318
6	cost understanding	n	60	30	30	30	30
		range	1 - 7	2 - 7	1 - 7	1 - 7	1 - 7
		mean	4.767	6.600	2.933	4.533	5.000
		s.d.	2.651	1.037	2.504	2.801	2.519

Table J-I (continued). Descriptive statistics for the post-simulation questionnaire responses.

			Condition				
Question Number	Question Content		Overall	High Cost	Low Cost	High Status	Low Status
7	cost check	n range mean s.d.	60 1 - 7 5.250 1.723	30 2 - 7 5.567 1.455	30 1 - 7 4.933 1.929	30 1 - 7 5.233 1.654	30 1 - 7 5.267 1.818
8	familiarity with flying	n range mean s.d.	60 1 - 7 1.717 1.354	30 1 - 6 1.900 1.447	30 1 - 7 1.533 1.252	30 1 - 7 1.767 1.431	30 1 - 6 1.667 1.295
9	flying experience	n range mean s.d.	60 0(no)- 1(yes) .033 .181	30 0(no) - 1 (yes) .033 .183	30 0(no) - 1 (yes) .033 .183	30 0(no) - 1 (yes) .033 .183	30 0(no) - 1 (yes) .033 .183
10	familiarity with games	n range mean s.d.	60 1 - 6 1.783 1.236	30 1 - 6 2.000 1.414	30 1 - 5 1.567 1.006	30 1 - 6 1.633 1.129	30 1 - 5 1.933 1.337
11	sex	n	60 32 F 28 M	30 16 F 14 M	30 16 F 14 M	30 16 F 14 M	30 16 F 14 M
12	age	n range mean s.d.	60 18 - 26 19.4 1.597	30 18 - 22 19.1 1.242	30 18 - 26 19.7 1.86	30 18 - 26 19.233 1.695	30 18 - 23 19.567 1.501

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